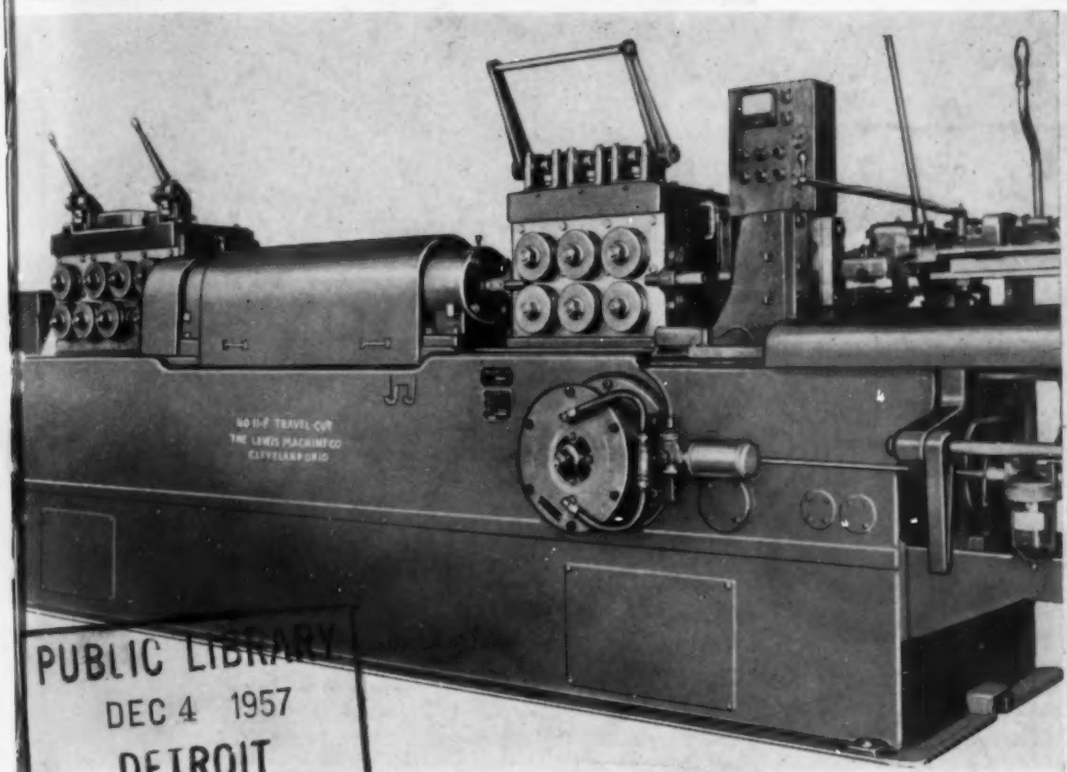
Iron AND Steel
ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907
ENGINEER

NOVEMBER, 1957 TECHNOLOGY DEPT. TABLE OF CONTENTS, PAGE 3



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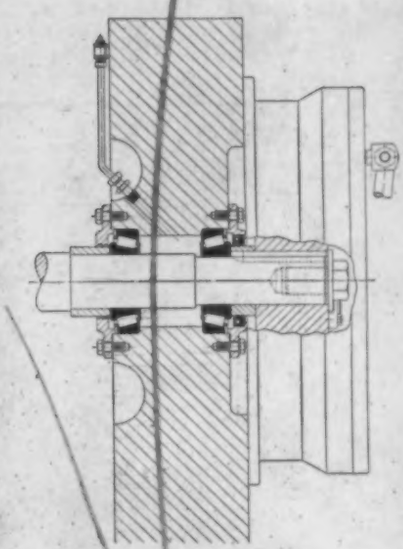


How **THE LEWIS MACHINE CO.**, Cleveland, Ohio, mounts the flywheel of its Model 11-F Travel-Cut Wire Straightening and Cutting Machine on Timken bearings to provide stability, dependable performance, economical operation.

How TIMKEN® bearings keep flywheel stable on automatic wire straightening and cutting machine

TO take the varying loads of automatic wire straightening and cutting, the bearings in this Lewis Model 11-F Travel-Cut have to be extra tough and virtually friction-free. That's why The Lewis Machine Company uses Timken® tapered roller bearings for the flywheel, feed rolls and drive—38 in all. Timken bearings keep the flywheel stable and rotating freely, position gears and feed rolls accurately even under heavy loads.

EXTRA LOAD-CARRYING CAPACITY. Full line contact between their rollers and races gives Timken bearings extra load-carrying capacity. Tapered design lets Timken bearings take *both* radial and thrust loads in any combination. The flywheel doesn't wobble. Gears and feed rolls *stay* in position.

PRACTICALLY FRICTION-FREE PERFORMANCE. Because they're geometrically designed to roll true, and precision-made to live up to their design, Timken bearings virtually eliminate friction. They run smoother, last longer.

NO SHOCK PROBLEMS. Because they're case-carburized, Timken bearings' rollers and races have a hard, wear-resistant surface over a tough, shock-resistant core. They *absorb* shocks, reduce maintenance.

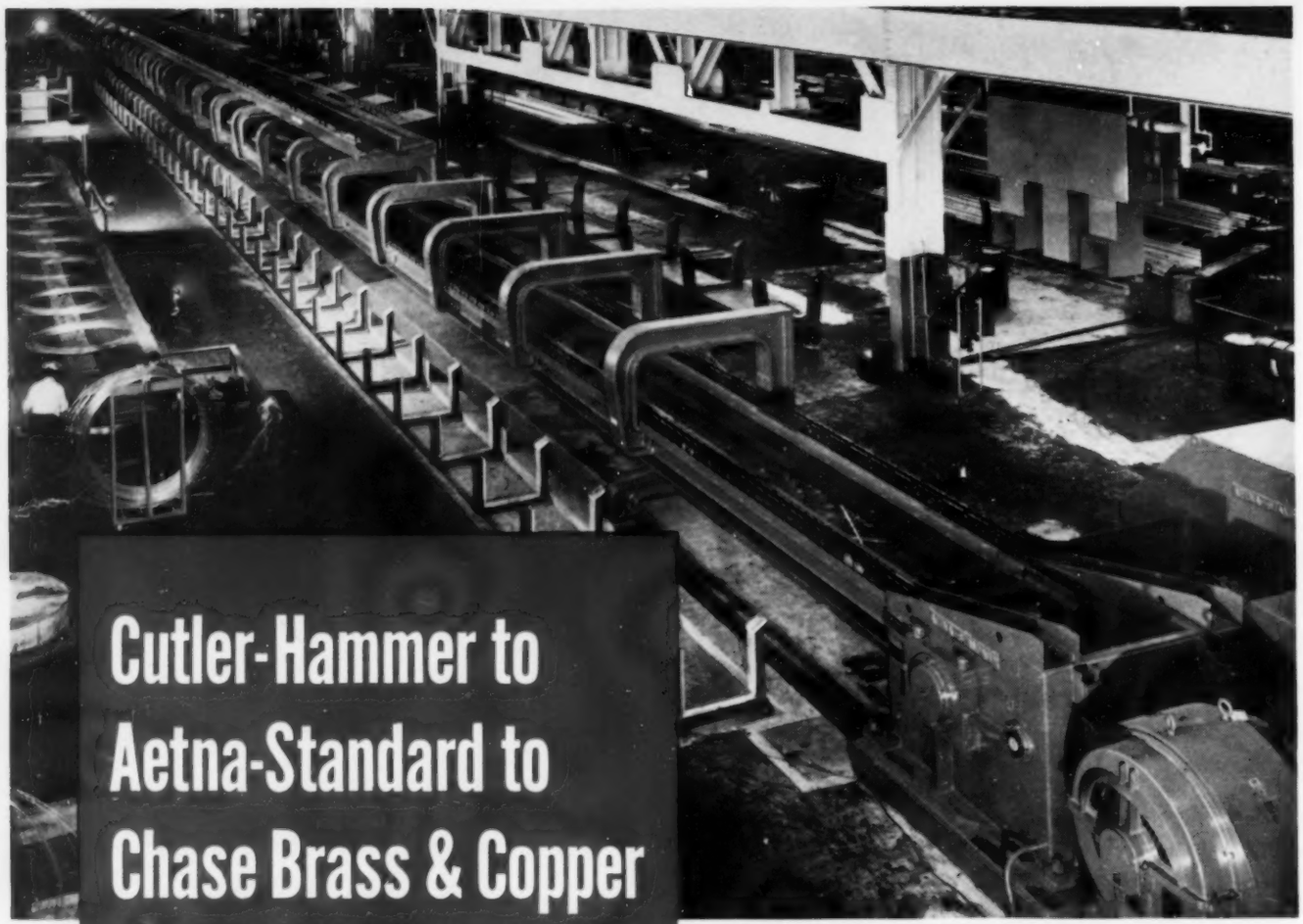
That's why it pays to specify bearings trade-marked "TIMKEN". The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.

TIMKEN TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS ROLL THE LOAD

See the next Timken Televent hour "The Innocent Yes..." on NBC-TV ...



Cutler-Hammer to Aetna-Standard to Chase Brass & Copper

This 400 foot tube drawbench simultaneously draws five tubes to a maximum length of 210 feet. Cutler-Hammer Control varies the drawing speed between 110 and 330 feet per minute.

It takes teamwork to win, and it takes teamwork to develop new and better machines for industry. This mammoth 400 foot Tube Drawbench was constructed by the Aetna-Standard Engineering Company, equipped with Cutler-Hammer Motor Control and installed at the Cleveland Mill of the Chase Brass & Copper Company. Engineers from all three companies worked together to produce this amazing machine, the longest drawbench in the copper and brass industries. Here again is another example where Cutler-Hammer Control was specified because of its reputation for dependability and the design leadership Cutler-Hammer has displayed during the past 65 years. You, too, will find it pays to insist upon Cutler-Hammer for the practical solution to all your control problems involving mill machines and processes.

CUTLER-HAMMER, Inc., 1269 St. Paul Avenue, Milwaukee 1, Wisconsin. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto.

CUTLER·HAMMER
MOTOR CONTROL
C-H

Cutler-Hammer Control on a rebuilt sheet temper pass mill.

Cutler-Hammer Control on a 44" taper mill.

Cutler-Hammer Control on a giant ore bridge.

Cutler-Hammer Control on a 10 ton soaking pit crane.

LOOK TO CUTLER-HAMMER MILL EXPERIENCE . . . AS BROAD AS IT IS LONG

IRON AND STEEL ENGINEER; published monthly by Association of Iron and Steel Engineers at 20th and Northampton Sts., Easton, Pa. Editorial and advertising offices, 1010 Empire Bldg., Pittsburgh 22, Pa. Entered as second class matter at Easton, Pa.

YOU KNOW US FOR...

CONTINUOUS BUTT WELD PIPE MILLS · SEAMLESS PIPE & TUBE MILLS
ELECTROLYTIC TINNING LINES · CONTINUOUS GALVANIZING LINES
SHEAR & TRIM LINES · DRAWBENCHES · ROLLS · SHEET CLASSIFIERS

BUT DO YOU KNOW US FOR ALL THESE?

Tube Expanders
Billet Peelers
Straighteners
Uncoiler-Levellers
Beveling & End Facing Machines
Levellers (2 and 4 High)
Rectifier Levellers
Heavy Plate Levellers
Stretcher Levellers
Coil Boxes

Reels (Pay-Off and Tension)
Upcoilers
Pilers
Scrap Ballers
Scrubbing and Drying Lines
Continuous Strip Picklers
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Multi-Strand Tube Cold Rolling Mill

Cracker Shears
Push Pointers
Tilting Head Presses
Extruders
Plastic Pipe Equipment
Continuous Automatic Mills for Rubber & Plastics
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Bull Blocks

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THE AETNA-STANDARD ENGINEERING COMPANY

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GENERAL ELECTRIC ANNOUNCES . . .

NEW surface-mounted • desk-mounted mill-duty master switches

NEW SMALL SIZE

Both General Electric master switches feature new small size. The surface-mounted switch is 25 percent smaller than previous models, and the desk-mounted switch is the smallest switch of its type on the market today!

NEW PHENOLIC CAMS

Rugged phenolic cams are impregnated with graphite to increase their service life. These U-shaped cams are easily interchanged to alter the contact sequence. This is done without complete disassembly of the switch.

NEW STEEL CAM FOLLOWERS

Steel cam followers actuate the contacts with a positive action. These cam followers swing clear to allow access to internal switch components. G-E cam followers are designed for millions of operations with minimum maintenance.

NEW CONTACT BLOCKS

Unit-type contact blocks are interchangeable between both types of General Electric master switches, thus reducing the number of spare parts required. Silver-tipped contacts give long service life with little or no maintenance.

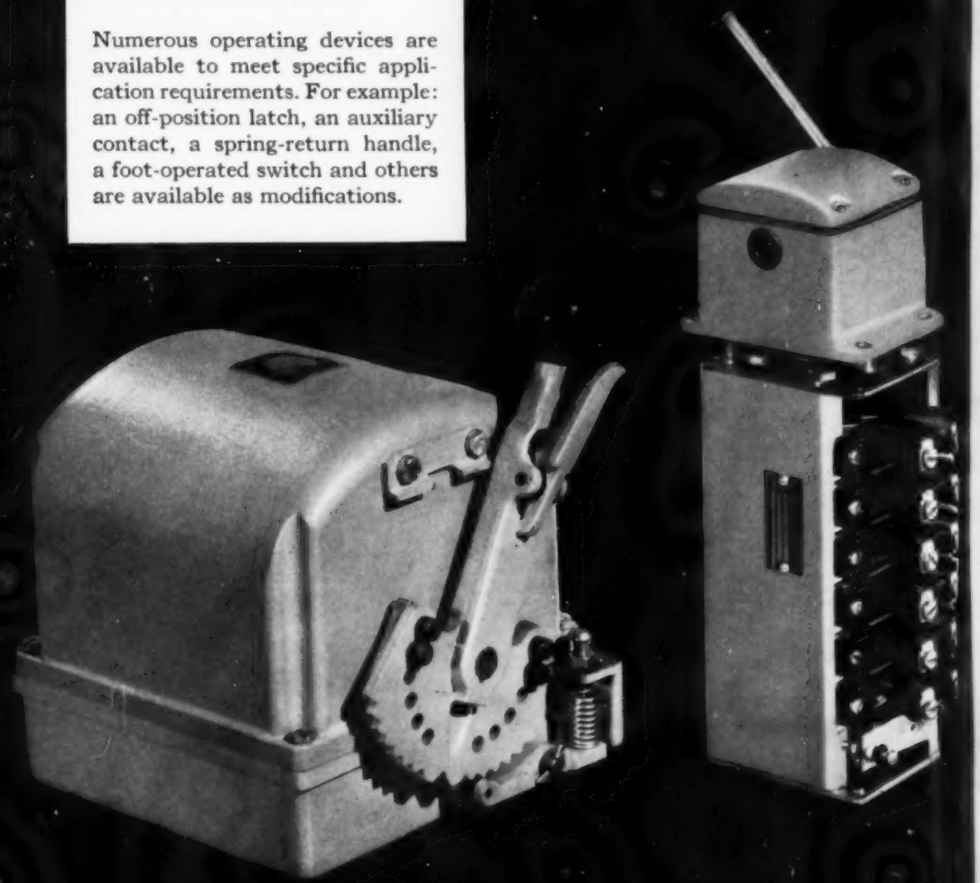
NEW OPERATING DEVICES

Numerous operating devices are available to meet specific application requirements. For example: an off-position latch, an auxiliary contact, a spring-return handle, a foot-operated switch and others are available as modifications.

NEW BULLETIN AVAILABLE

Like to know more? For complete information on General Electric's new mill-duty master switches, contact your General Electric Apparatus Sales Office. And write today for the new descriptive bulletin, GEA-6706, to Section 784-9, General Electric Company, Schenectady, N. Y.

Industry Control Dept., Roanoke, Virginia.



Progress Is Our Most Important Product

GENERAL ELECTRIC

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NOVEMBER, 1957 VOLUME XXXIV NUMBER XI

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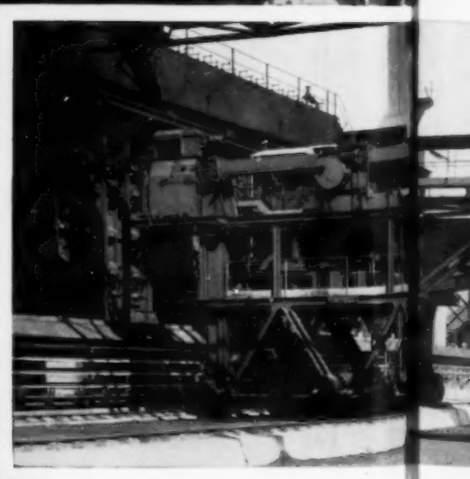
CLARK



This Clark Control panel in a large mid-west steel mill controls all the operations of the huge Wilputte coke pusher shown in the inset.

backs dependability of VARI-TIME® principle with LIFETIME GUARANTEE...

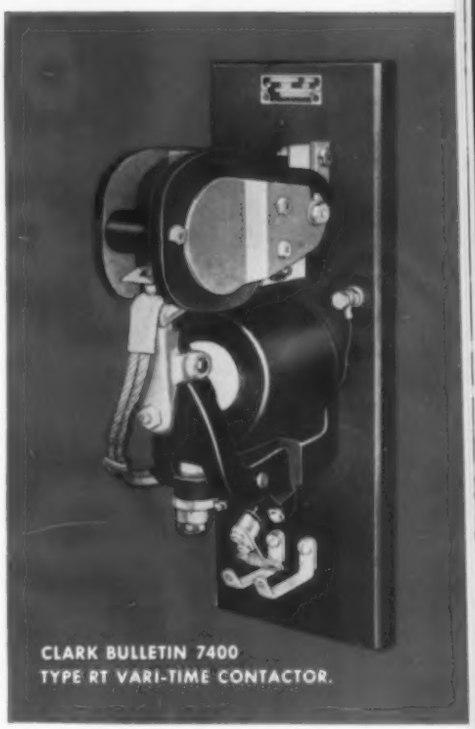
Clark Vari-Time contactors with built-in adjustable time delay are the heart of Clark DC control for heavy-duty applications. They are particularly suited to the rugged service demanded of steel-mill control equipment.

The timing element or core in Vari-Time contactors is a hermetically-sealed unit that *never requires maintenance or repair.* It has been so successfully trouble-free on thousands of installations over the past 30 years that we do not hesitate to reaffirm this original guarantee:

"The Clark Controller Company will replace free of charge any Vari-Time Core which will fail in service during the life of the controller."

Since the time delay unit is an integral built-in component of Vari-Time contactors, the need for accelerating relays is eliminated. This substantially reduces the amount of panel wiring. There are no timing relays that require maintenance. Stocking of repair parts is simplified because all wearing parts for both main and accelerating contactors are duplicates.

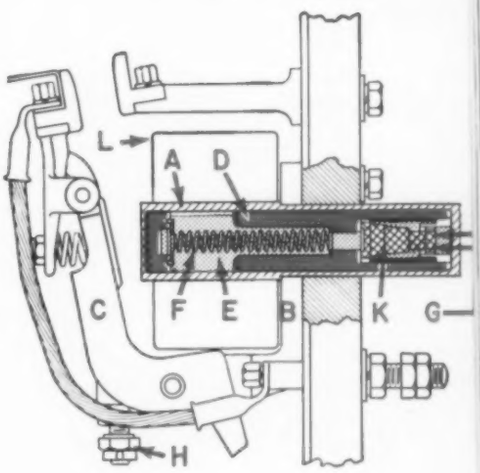
Let a Clark Application Engineer show you how the Clark "Vari-Time" principle can provide greater dependability and reduced maintenance on your D.C. control.



CLARK BULLETIN 7400
TYPE RT VARI-TIME CONTACTOR.

HERE'S HOW IT WORKS

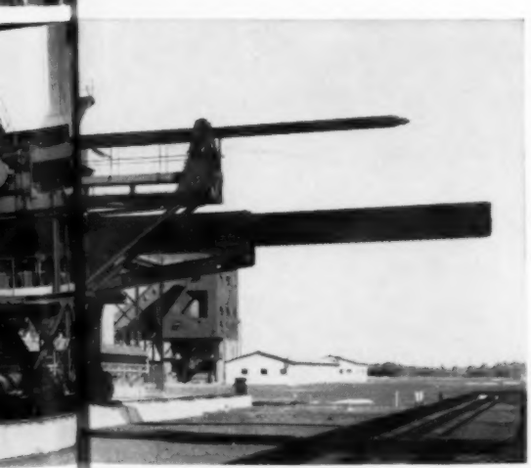
This drawing shows a cross-section of a Vari-Time contactor in de-energized position. When coil "L" is energized, a magnetic flux is set up through brass cylinder "A", steel frame "B" and steel armature "C". Since brass cylinder "A" is non-magnetic, the armature "C" does not close main contacts until the steel plunger "D" is pulled forward into the center of the coil. Liquid "E" retards this motion as it passes through orifice "G"



Time delay is provided by this action. Valve "K" is designed to compensate for variations in voltage by controlling the size of orifice "G" to maintain uniform timing.

As steel plunger "D" nears the center of coil "L", build-up of flux causes armature "C" to close the main contacts. Steel plunger "D" stays at the front of brass cylinder "A" as long as coil "L" is energized.

Armature "C" immediately drops open when coil "L" is de-energized. The design of valve "K" permits free flow of liquid "E" on the return stroke, and spring "F" snaps plunger "D" back instantly. 3 to 1 timing adjustment is provided by adjustable stop "H".



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TENTH OF A SERIES

Customer's Report

"Four Big Reasons why single stack furnaces are easier, faster and less expensive to install"

"The Single Stack Furnace has four major advantages, installationwise," a Director of Purchasing for a large steel producer told us when asked his views. "First, and important in this day of high construction costs, we were able to use a ❶ lighter, smaller building for a given tonnage because the Single Stack equipment does not require nearly as heavy a crane or handling equipment ❷, and ❸ it needs less space both productionwise and storagewise. Finally, this lighter equipment does not require heavy substructures. In our case, by utilizing the portable base, the substructure consisted only of ❹ a simple network of shallow trenches."

There are many other reasons why the Lee Wilson Single Stack is today the industry's preferred annealing method. When next you're considering annealing, be sure to talk with a Lee Wilson engineer.

Only Lee Wilson Furnaces Give You All These Advantages

1. GREATER FLEXIBILITY
2. MORE UNIFORM HEAT APPLICATION
3. IMPROVED CUSTOMER SERVICE
4. HIGHER PRODUCTION
5. BETTER LOAD FACTOR
6. MINIMUM PROCESS INVENTORY
7. REDUCED LABOR COST
8. BETTER OPERATING CONDITIONS
9. LOWER MAINTENANCE COST
10. REDUCED INSTALLATION COSTS

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MAKE THE BEST METALS BETTER

* ORIGINATORS AND LEADING PRODUCERS OF SINGLE-STACK RADIANT TUBE FURNACES

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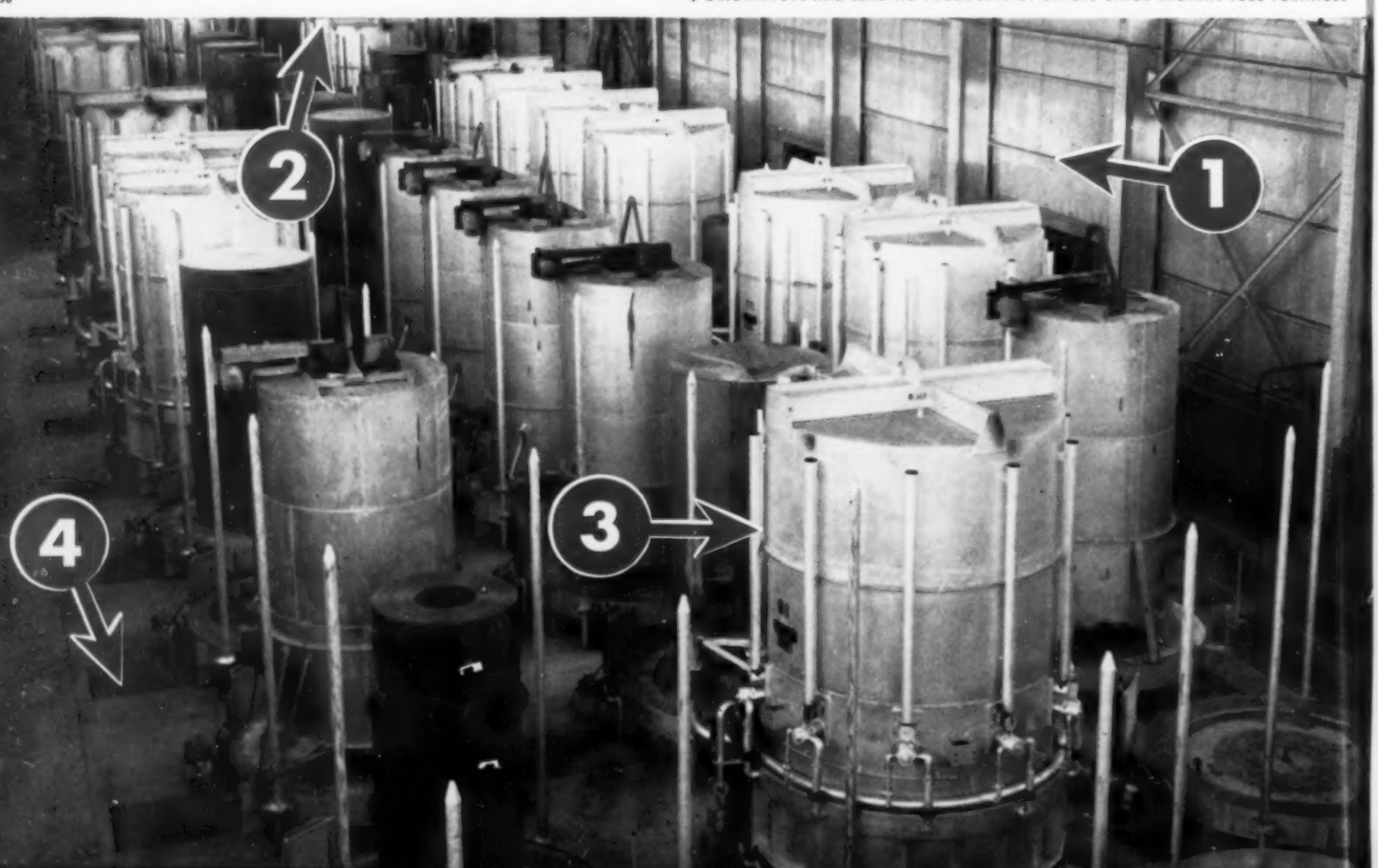

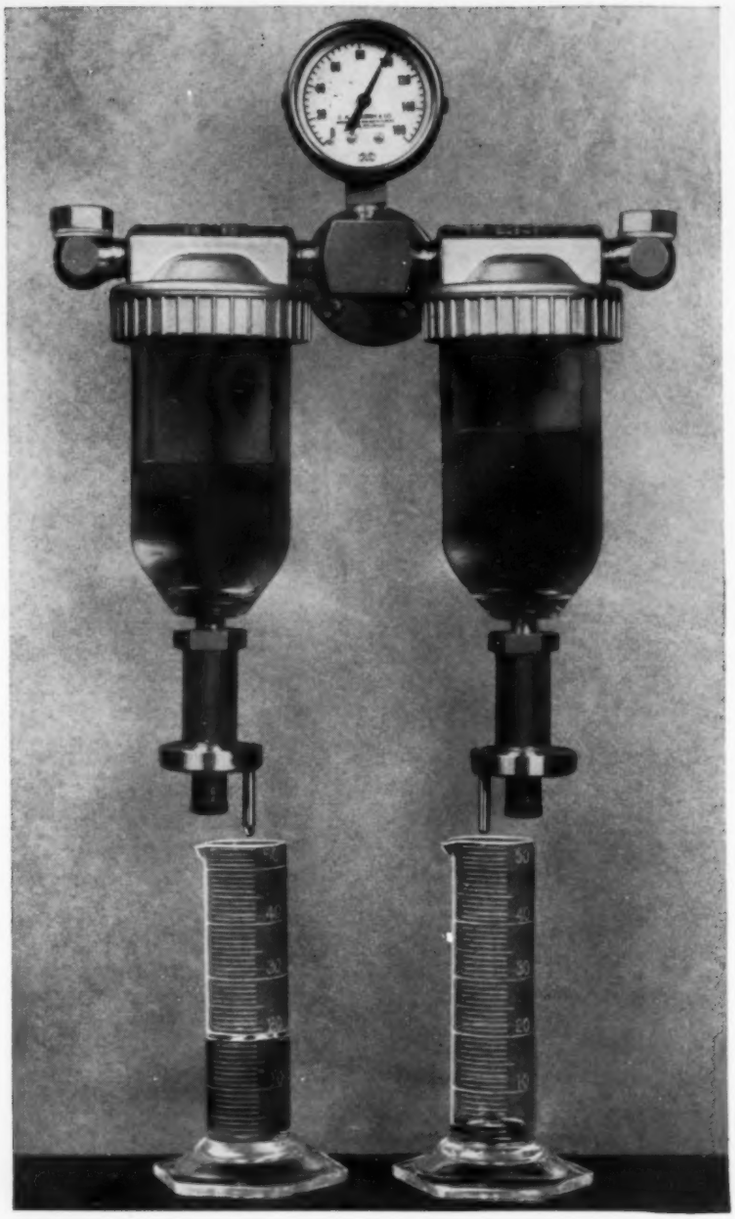

ANTILEAK DEMONSTRATION

Suntac oil in one chamber, your present hydraulic oil of the same viscosity in the other. Both oils are forced out through sintered bronze bearings. In this photograph, pressure of 100 psi caused a straight mineral oil to leak out four times faster than Suntac.

SUNTAC CUTS HYDRAULIC OIL LOSS AS MUCH AS 75%

See this demonstration in your plant

Take about five minutes at your own desk to learn how Suntac® oils stay put in hydraulic systems . . . reduce oil loss through loose joints and worn fittings.

Match Suntac against the hydraulic oil you're now using—see how the exceptional non-gummy antileak characteristics of Suntac can reduce your oil losses as much as 75%. *Some users have even reported savings of 90%.*

Call Your Sun Representative

Have him arrange with a Sun Lubrication Engineer to give you and your staff a private demonstration. For further information on the uses of Suntac in hydraulic systems and in general lubrication, write to SUN OIL COMPANY, Philadelphia 3, Pa., Dept. IS-11.

SUNOCO

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY PHILADELPHIA 3, PA.

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IN CANADA: SUN OIL COMPANY LIMITED, TORONTO AND MONTREAL

Used where metals and slags are poured . . .

HARBISON-WALKER
Black Patch

Plastic Graphite Refractory

• reduces costs • improves service

• assures cleaner metal

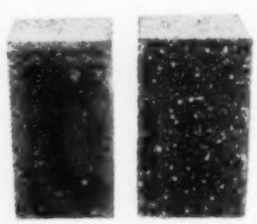
Monolithic linings formed with H-W BLACK PATCH withstand severe corrosive and erosive action of various metals and slags, resist wetting and penetration and remain cleaner because there is less slag adherence.

When heated, Black Patch develops a strong ceramic set and a close texture which, together with the oxidation inhibitors, greatly retard burning of the carbon. In addition, the graphite component enhances the high resistance to thermal shock and increases the refractoriness of H-W BLACK PATCH.

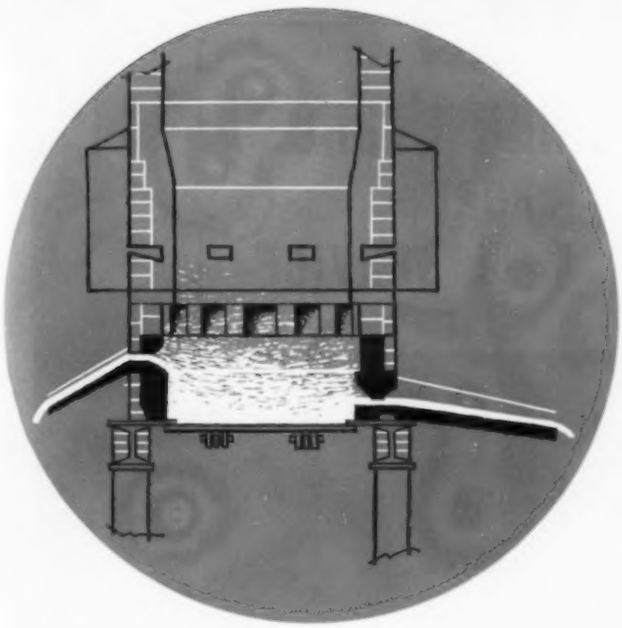
Among the many important applications in which H-W BLACK PATCH serves to great advantage are:

- Holding Ladles
- Pouring Ladles
- Hand Ladles
- Malleable Furnace Runners and Spouts
- Blast Furnace Runners
- Cupola Runners and Spouts
- Cupola Iron and Slag Tapping Holes
- Cupola Tuyere Facings

H-W BLACK PATCH is available in the form of plastic slabs 12"x9"x1", in a compact mass in drums, or as a dry mixture in sacks, for mixing with water when used.



5-HOUR HIGH TEMPERATURE TEST SHOWS BLACK PATCH SUPERIORITY Result of 5-hour test at 2730°F. Note difference in degree of oxidation. Test piece at left—ordinary graphite plastic; at right—H-W BLACK PATCH.



Harbison-Walker Black Patch used in many applications, provides important benefits such as cleaner metal, lower costs and longer lining life.

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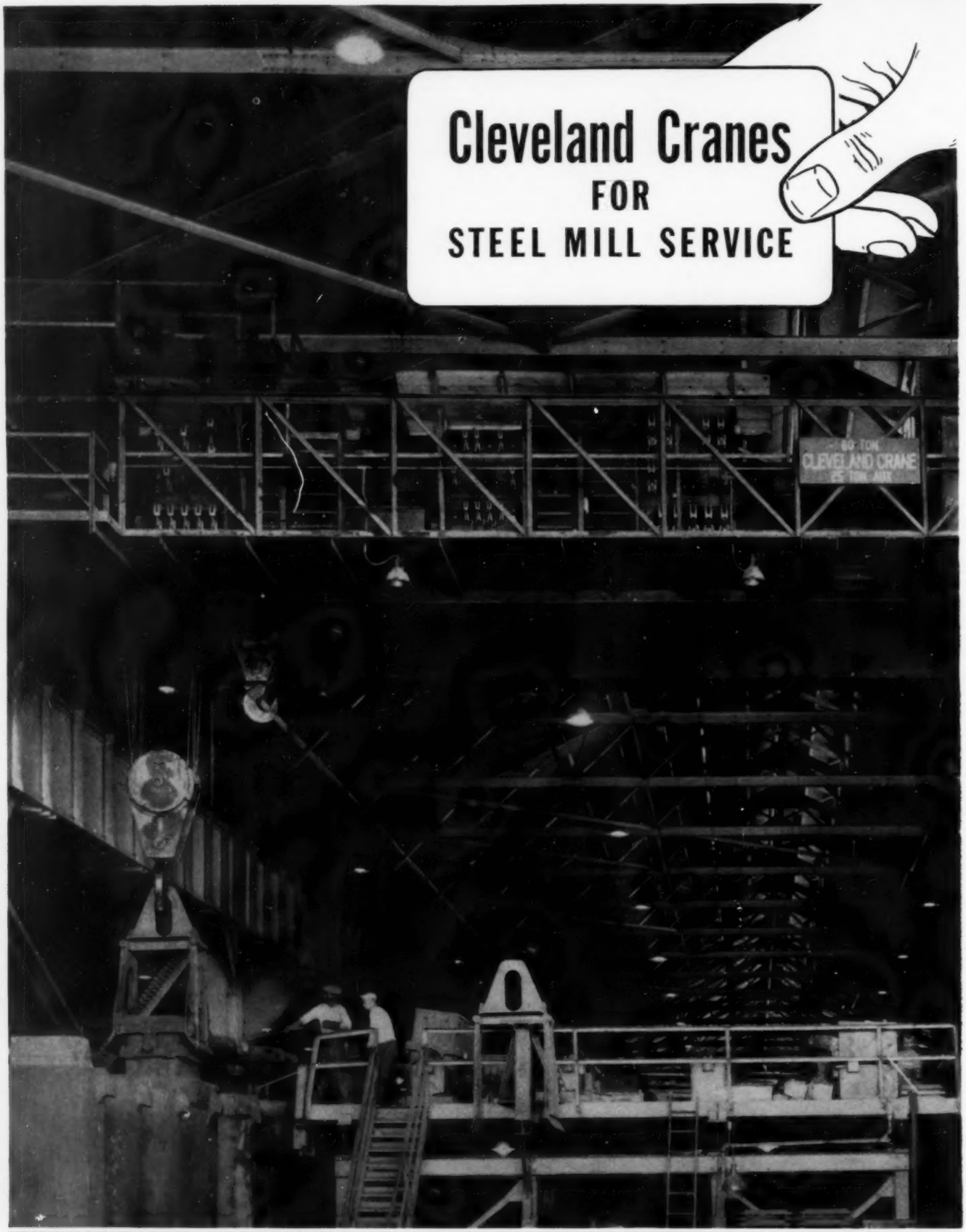
AND SUBSIDIARIES

World's Most Complete Refractories Service

GENERAL OFFICES: PITTSBURGH 22, PENNSYLVANIA



CLEVELAND CRANES

MODERN ALL-WELDED STEEL MILL CRANES

5031 EAST 289th ST.
WICKLIFFE, OHIO

Crops and Shorts

IN spite of all the complaints heard during the past summer, steel production in the first three quarters of this year set a record at 87,721,169 net tons. Even though the expected fall upturn seems to be lacking in steam, production for the year will exceed 114,000,000 tons—the third highest.

True, this will be only 85 to 86 per cent of capacity but it must be admitted that its good operations—and profitable, too.

▲

ADDRESSING the American Bankers Association, Roger M. Blough, chairman of the board of United States Steel Corp., called for a rise in productivity, with future wage increases being held to levels supportable by rising productivity, and for increased personal savings as aids in solving America's inflation. He described the inflation puzzle as "the big debate between political fantasy and economic fact," and said that if the American people understand this problem, they will provide the ultimate controls and the ultimate solution to inflation. He added: "They have the greatest power in the world, the power of informed public opinion; and they have the greatest stake in the outcome of the battle against the loss of the purchasing power of the dollar."

▲

THEY used to say it's too late to shut the barn door after the horse has been stolen. Now, with these overgrown modern cars, that's the only time you can shut the garage door.

And these new cars—they're longer, wider, lower—and higher.

▲

A COAST-to-coast poll by the American Institute of Public Opinion shows that more than six out of every ten voters say they would vote for a "right-to-work" law, 27 per cent would vote against it and 10 per cent expressed no opinion. Among union members, however, the poll showed almost the exact opposite.

Senator Frank Lausche of Ohio has said: "I think the right to work in our country is just as sacred as the right to vote and the right to jury trial. I don't believe any organization in our country should be vested with the right and the power to say to any American, 'You shall not work unless you join my organization.' That to me is the very antithesis of liberty as contemplated by the Constitution of the United States."

ISN'T it funny how everyone else reaches old age before we do?

▲

THE National Association of Manufacturers is conducting a campaign to "bring government back home"—a good slogan and an even better idea. NAM believes that, in a country which seeks to retain free, popular government, service responsibilities should be performed by the smallest units competent to handle them satisfactorily and economically.

This is along the same line as a statement we have made here sometime ago: The closer you keep the taxing body and the spending body, the more economy you'll have.

▲

IF any readers have sons who are showing extreme interest in girls, don't worry about it. It's only a developmental phase and should last only about 50 years.

▲

THE United Steel Workers of America has set up a million-dollar fund to help children of its members go to college. The fund will be used for student loans, to be repaid after recipients have completed their education and gone to work.

▲

HIGH pressure recruiting for college graduates has led to some abuses and has led to the formation of regulations for recruiting. Issued jointly by the College Placement Council and the United States Chamber of Commerce, the code lays down some general principles and lists the responsibilities of the employer, of the college and of the student.

▲

IT'S impossible for a woman to be married to the same man for 50 years. After the first 25, he's not the same man.

▲

A RECENT study by Dun and Bradstreet, Inc., showed business failures to be rising at a slower rate than the total business population. During the first six months of 1957, 54 businesses out of 10,000 failed with losses to creditors. More than half of these failures were in businesses less than five years old, and over half had liabilities of less than $25,000. More than 90 per cent of failures were attributed to incompetence or lack of experience.

▲

THE average hourly payroll cost for wage earners in the iron and steel industry reached a record $2.99 in August, according to the American Iron and Steel Institute. This does not include an estimated average cost of over 29 cents per hour for pensions, social security and insurance. Wage earners worked an average of 36.5 hours a week in August.

▲

PRODUCTION of canned foods has increased twenty-fold in the last 50 years. Per capita consumption of canned fruit is now about 22 lb and of canned vegetables about 38 lb per year. Add to these all the frozen foods and it's plainly evident—it just doesn't pay to cook anymore.

Westinghouse mill motors with **silicone insulation**

For longer motor life under the toughest operating conditions

Silicone insulation for longer motor life . . . improved field coil design for greater capacity and cooler operation . . . heavy-duty shaft, bearing and housing design to take high torque loads . . . make the Westinghouse Hevi-Duty Mill Motor the most rugged package of power you can buy.

New silicone insulated armatures and the exclusive Westinghouse solid mass design with multi-dip finishing make it five times tougher for load surges to affect armature coils.

Maintenance is easy, too. New openings in lower frame give quick, easy access to commutator and brush rigging for inspection or repair. Silicone-insulated armatures and field coils are interchangeable with old-style units.

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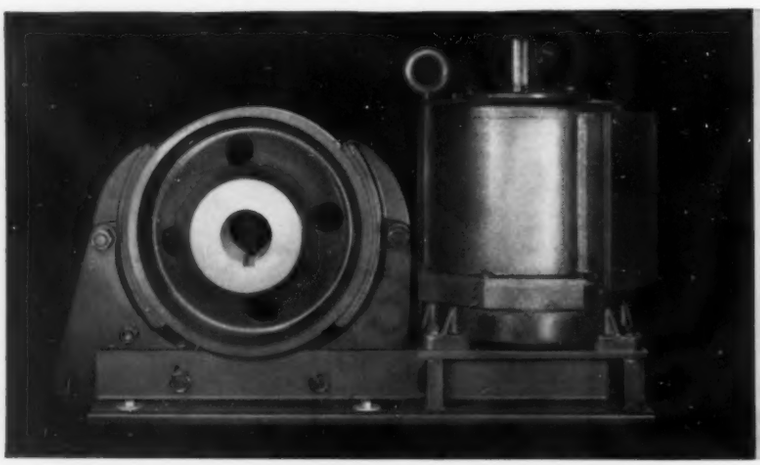

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When selecting mill motors remember that Westinghouse can furnish motors and brakes as one unit. Only Westinghouse D-C Magnetic Brakes are self-adjusting. This exclusive self-adjustment design means long brake life and minimum maintenance. For more information on the only Self-Adjusting D-C Magnetic Brake on the market ask for B-6548.

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Wasting time and profits searching for the right gear oil for your machinery? Atlantic has the key to your problem, because our long experience has made us familiar with your lubricating needs. We've developed the products that can do any lubricating job to perfection . . . at low cost . . . for every wheel that turns in industry.

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57" AND 66" DIAMETERS

New throughout, these EC&M **Type SB Lifting Magnets** have many improvements over previous-design bolted magnets. They are mechanically stronger, have improved coil construction, and high lifting capacity due to a better magnetic path. Tapered-head, through bolts simplify field replacement of worn pole shoes...permit quick access to coil.

Strap aluminum coil winding is firmly anchored by top-plate held by bolts and screws. Continuous welds seal coil spool in magnet case and make it water-tight. Welds are easily ground or chipped off for field removal of coil.

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EC&M BOLTED MAGNETS complement the complete line of EC&M ALL-WELDED Magnets • For all the facts, Write for Bulletin 1300 SB

THE ELECTRIC CONTROLLER & MFG. CO.
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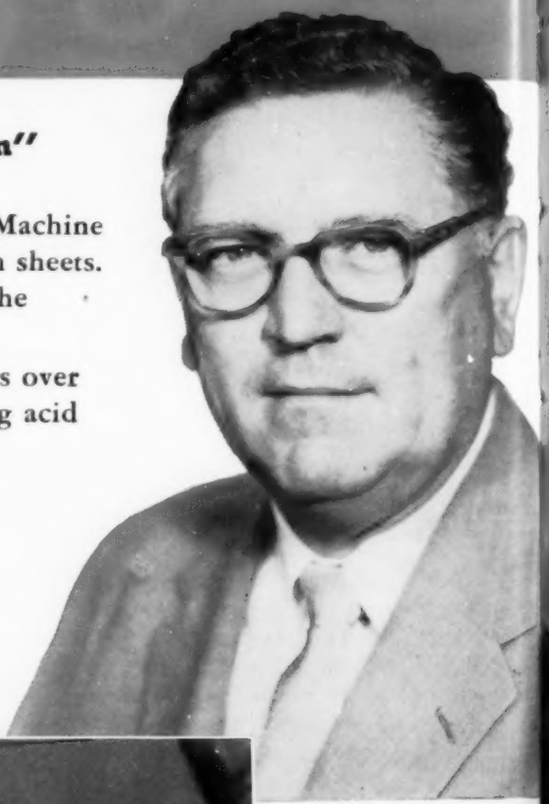
9251

"...an all-round solution to the problem of removing scale from sheets"

says T. A. SULLIVAN, Plant Manager,
Granite City, Ill. Works, A. O. Smith Corporation

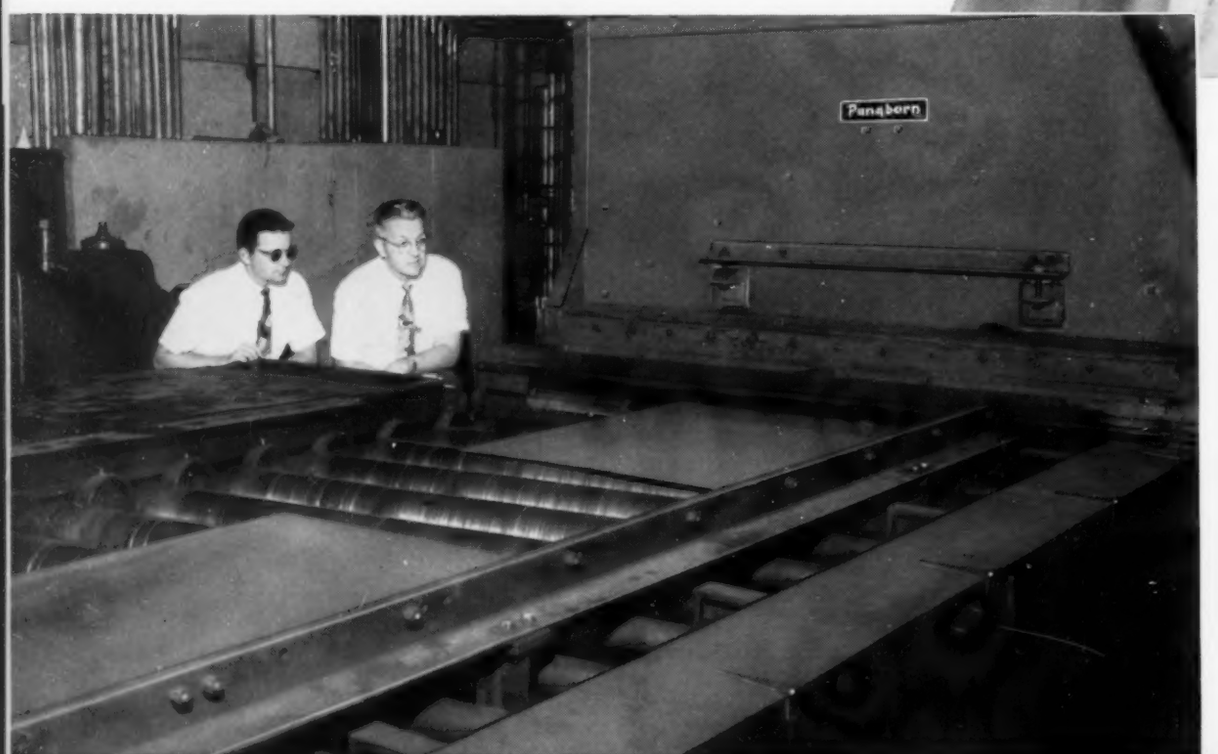


"Extremely pleased with high volume of production" of PANGBORN DESCALING MACHINE

"In many ways," says Mr. Sullivan, "the Pangborn Descaling Machine is an all-round solution to the problem of removing scale from sheets. We're extremely pleased with the high volume of production the machine is handling . . . it's fast and thorough."

And A. O. Smith management rates the following advantages over pickling equally important: conserving floor space—eliminating acid disposal problems and hazards to employees—better working conditions and plant housekeeping—more fully automated plant that saves time and labor.

If you're descaling sheets, plates, coils and rods, write today for Bulletin 608, PANGBORN CORP., 4400 Pangborn Blvd., Hagerstown, Md. *Manufacturers of Blast Cleaning & Dust Control Equipment.*



At A. O. Smith, sheets descaled on this Pangborn Descaling Machine draw easily, weld readily . . . and the fine matte surface takes a permanent bond.

Pangborn ROTOBLAST® cleans cheaper

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TANDEM COLD MILL

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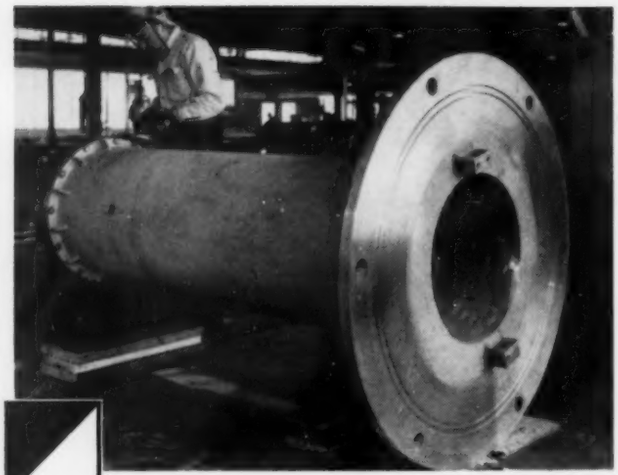
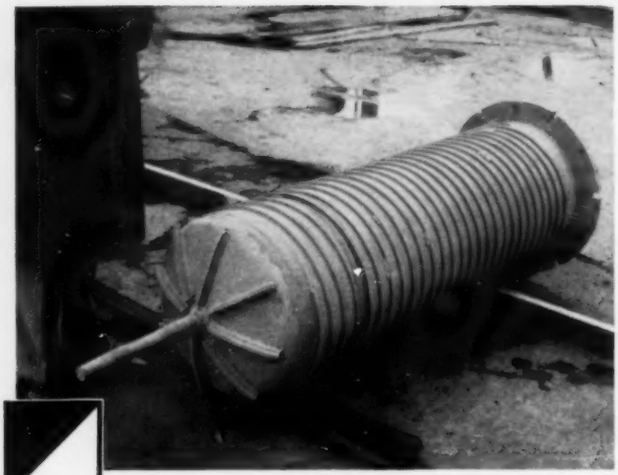
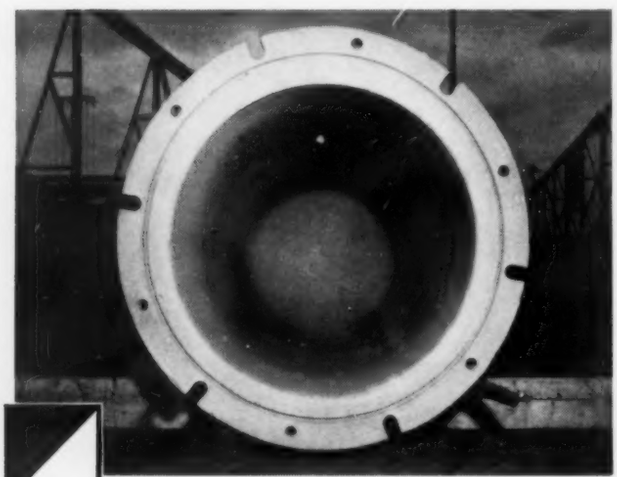


23" Diam. Copper Crucible for Vacuum-Melting of Steel, completely fabricated and machined, ready for installation.



Copper Mold with Water-Circulating Ribs.



Copper Mold for Melting Titanium.

Welding Copper Ribs on Heads for Copper Crucibles.

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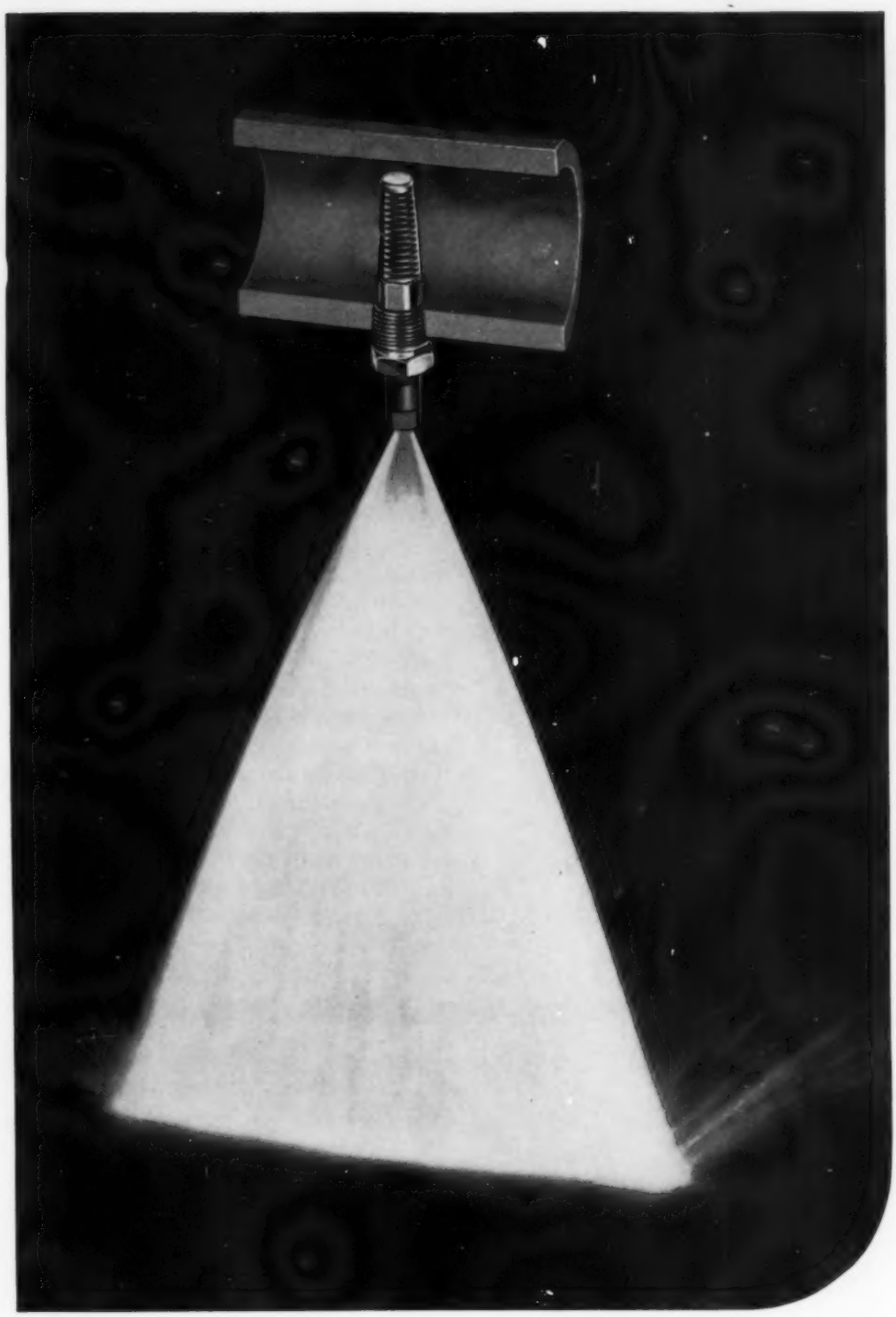

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with open, elliptical non-clogging orifice

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Clogging is practically eliminated by *elliptical*-shaped orifice . . . foreign matter goes right through.

CHOICE OF SIZES . . . offered in 16 different capacities . . . for every known descaling use.

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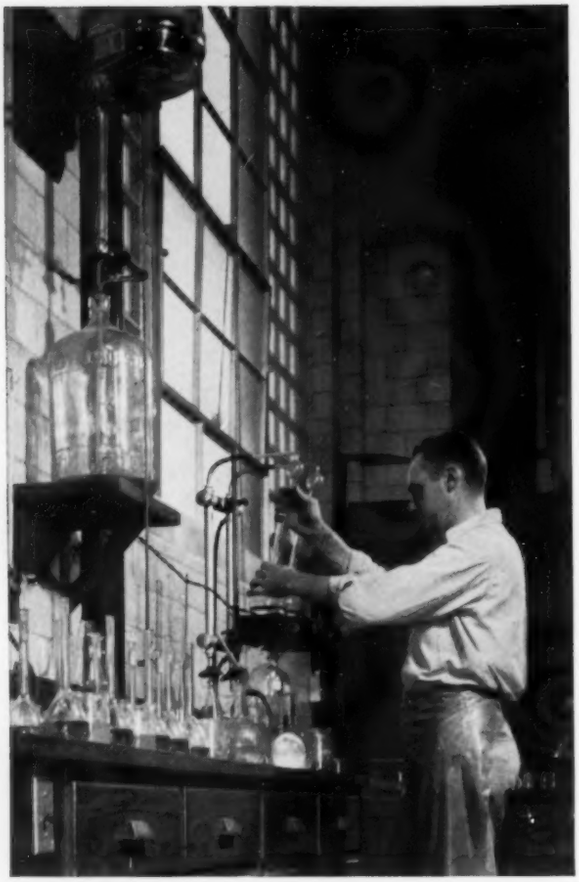
Spray Nozzles also supplied for such applications as Run-Out Table Cooling . . . Roll Cooling . . . Cooling Ingot Molds and many other uses. For complete information write for Catalog No. 24.



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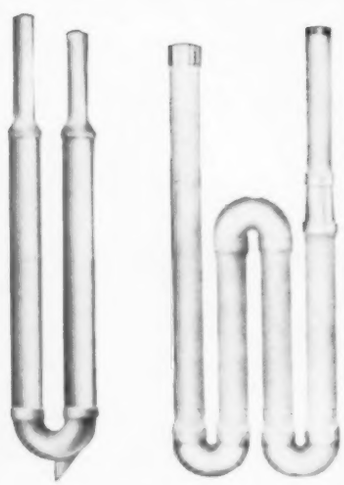

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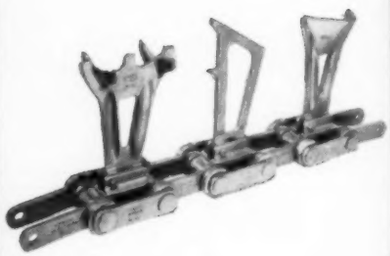


Thermalloy Carrier Blades and Chain...Three types of blades, mounted on *Thermalloy* conveyor chain.

AMERICAN Brake Shoe COMPANY

ELECTRO-ALLOYS DIVISION Elyria, Ohio

By MELVIN NORD, Patent Attorney, Detroit, Mich.

Patent Reviews

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents . . . . patents reviewed cover period May 28, 1957 through June 25, 1957 . . . .

PRODUCTION OF PIG IRON

▲ U. S. 2,793,946, issued May 28, 1957 to George R. Paschal, describes a method and apparatus for reducing iron ore, which yields a higher output per square foot of apparatus and per dollar of investment, and is adaptable to the use of fuel oil, gas or any grade of coal as fuel or reducer.

In Figure 1, the numeral 20 indicates a stack or furnace terminating at the upper end in an open top and at the lower end in a tapered bosh section 24. The furnace is similar to a blast furnace in dimensions, and is lined with a suitable refractory. The bottom of the furnace is closed with a refractory base 26. An annular bustle pipe 28 leads to tuyeres 30 at about the midpoint of the cylindrical section of the furnace. A second bustle pipe 32 leads from a number of tuyeres 34 at the point where the cylindrical section of the furnace joins the bosh 24. At the lower end of the bosh section 24 of the furnace are a set of tuyeres 35 and 36 through which fuel and air, respectively, are supplied under pressure. An exit pipe 37 for the products of combustion is located near the tuyeres 35 and 36.

The bustle pipe 28 is connected through a conduit 40 to the outlet side of a gas producer 42, consisting of an inner annular shell 44 which is provided with a loading opening 46 at its upper end and with an ash removal gate 48 at its lower end. A closure 50 seals the opening 46

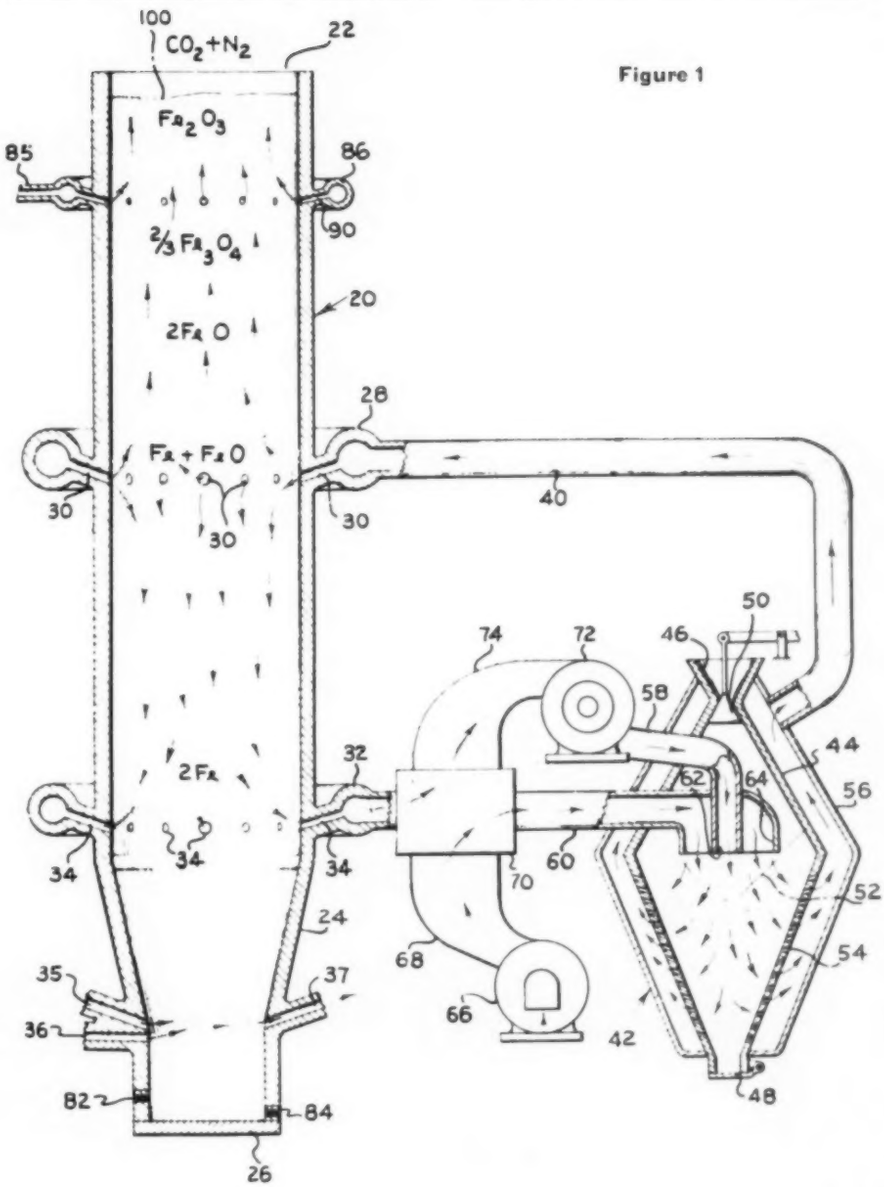


Figure 1

after the producer is loaded with coke or coal to the level indicated by the line 52. The lower section of the shell 44 is provided with a series of openings 54 which permit the free passage of gas through them, but which are upwardly inclined to prevent the passage of coke or coal particles or ash. The inner shell is surrounded by an outer annular shell 56 which collects and delivers the gases passing through the openings 54 and delivers them to the conduit 40. These gases consist principally of CO and N_2.

The required gases are supplied to the interior of the producer through conduits 58 and 60 which pass through both the inner and outer shells and terminate in concentrically arranged openings 62 and 64 respectively. Air is supplied by the conduit 60 by a blower through a conduit 68 and a heat exchanger 70.

The gas entering the bustle pipe 32 through tuyeres 34 is drawn through the heat exchanger 70, in heat exchange relation with the air supplied by the blower 66, by a blower 72. The cooling of the gases in heat exchanger 70 increases the pumping efficiency of the apparatus.

The fuel and air mixture entering the bosh through tuyeres 35 and 36 burns, thus melting the products of reduction. Openings 82 and 84 are provided at the bottom of the bosh, for the removal of liquid slag and iron.

A bustle pipe 86 near the top of the furnace is provided for preheating the ore, by blowing air into the furnace, and burning the fuel gas present at that point.

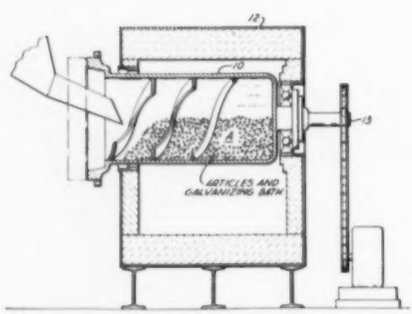
In operation, the furnace is loaded to the level shown at 100, with ore and flux, preferably in the form of pieces or pellets of relatively small size.

The principal reduction of the ore to Fe_3O_4 is complete at a level immediately below the air tuyeres 90. The reduction to FeO is complete at a point about two-thirds of the way down towards the reducing gas tuyeres 30. At the level of the tuyeres 30, about half the FeO will have been reduced to Fe. As the ore descends below the level of the tuyeres 30, down to the level of the tuyeres 34 (or slightly above them), the reduction is completed. The reduced iron is then melted in the bosh.

The off-gas leaving the top of the furnace consists substantially entirely of CO_2 and N_2 and need not be recovered, and a double bell arrangement is therefore not needed.

The patent also describes a number of modifications of the process.

Figure 2



GALVANIZING COMPOSITION AND PROCESS

▲ U. S. 2,793,965, issued May 28, 1957 to Henry F. Myers and Otto A. Proelss, assigned to United States Steel Corp., describes a method and coating composition for galvanizing small articles in drums, a procedure sometimes known as "hot rumbling."

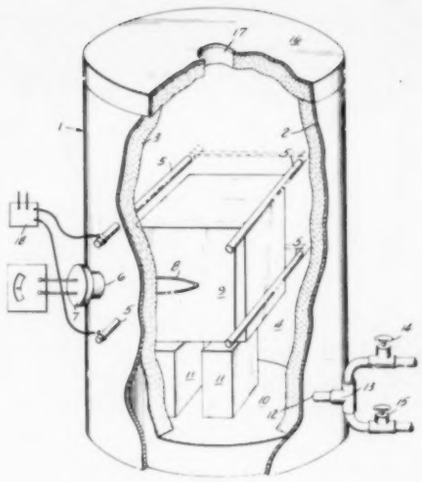
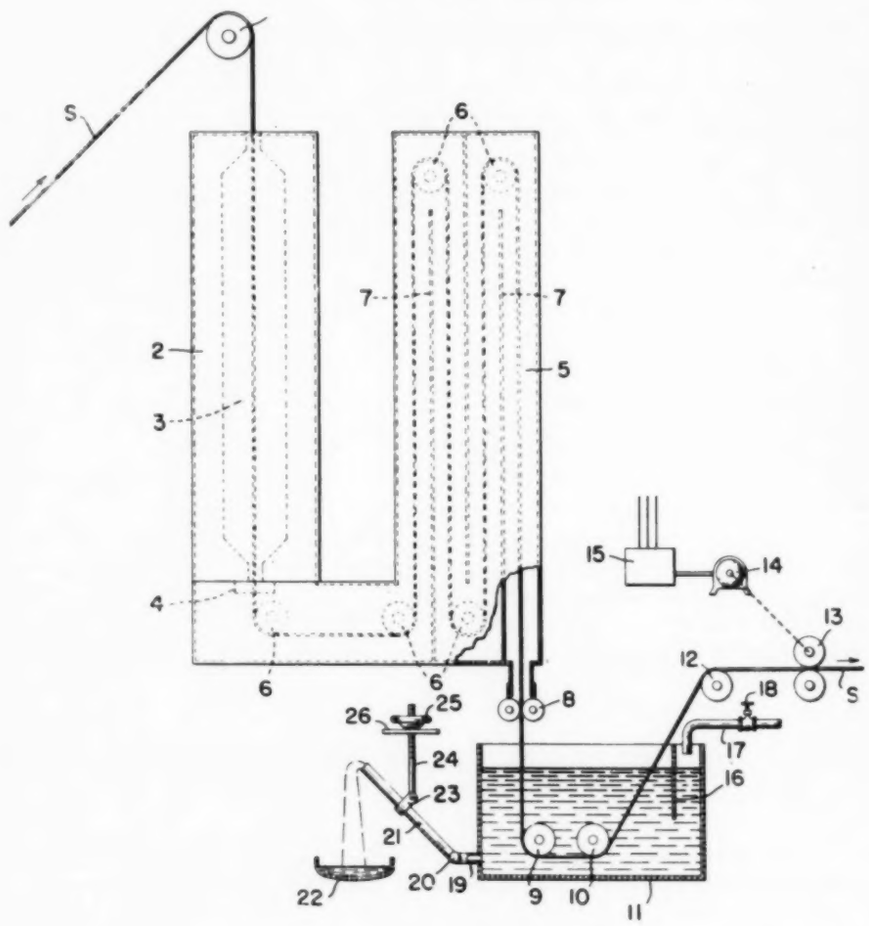


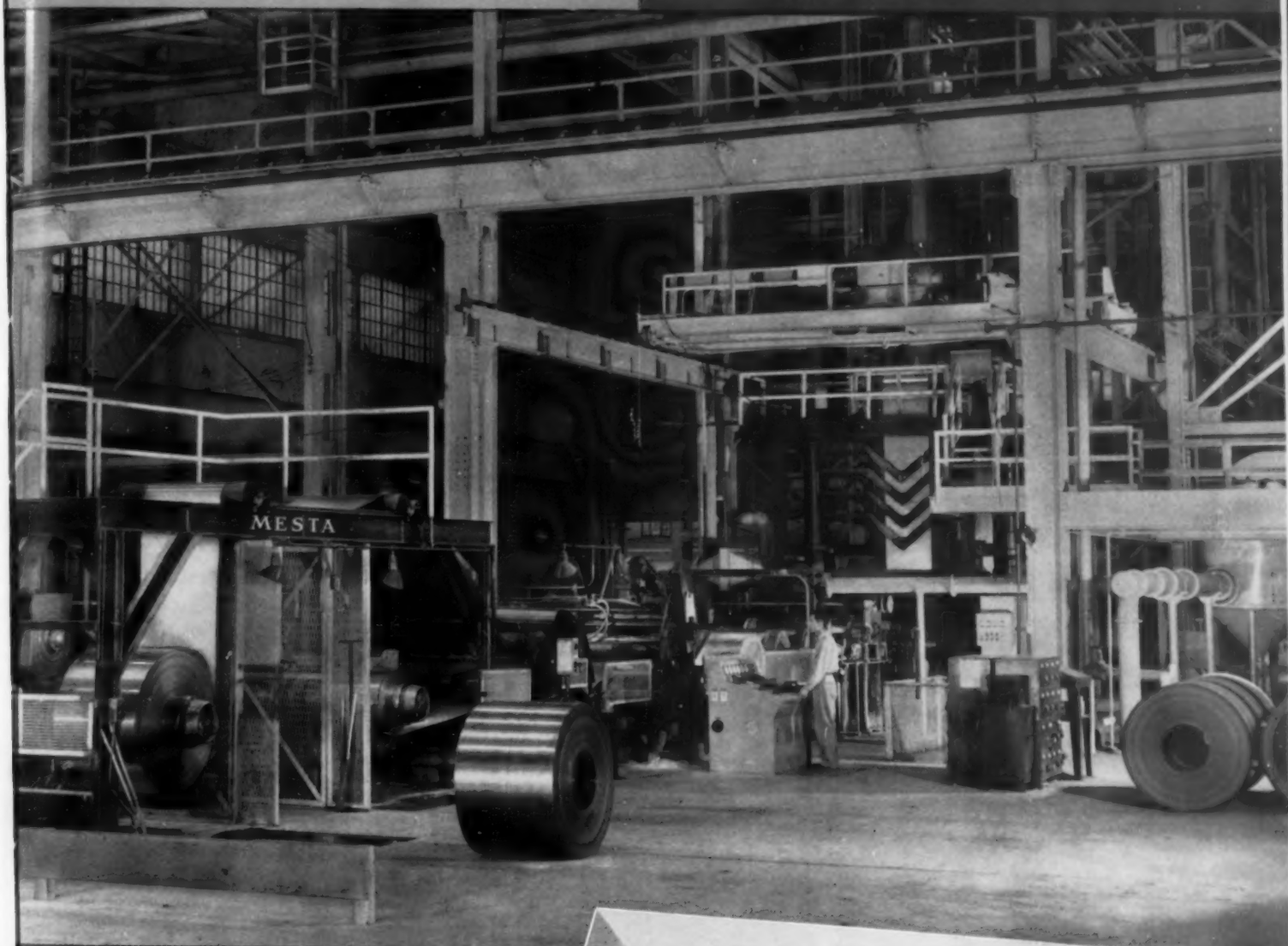
Figure 3

As shown in Figure 2, the apparatus consists of a rotatable drum 10, a suitably fired furnace 12 in which the drum is journalled, and a drive 13 for the drum. A charge of articles A, together with the galvanizing bath, are fed into one end of the drum.

Figure 4



CONTINUOUS CLEANING *and* ANNEALING LINES



MESTA CONTINUOUS CLEANING AND ANNEALING LINE FOR TIN PLATE WITH PAY-OFF REELS, DOUBLE SEAM WELDER, SHEAR, AND TENSION REEL

Designed and Built by MESTA

Designers and Builders of Complete Steel Plants

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PITTSBURGH, PENNSYLVANIA

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MACKINTOSH-HEMPHILL DIVISION, E. W. BLISS COMPANY, Pittsburgh 3, Pennsylvania

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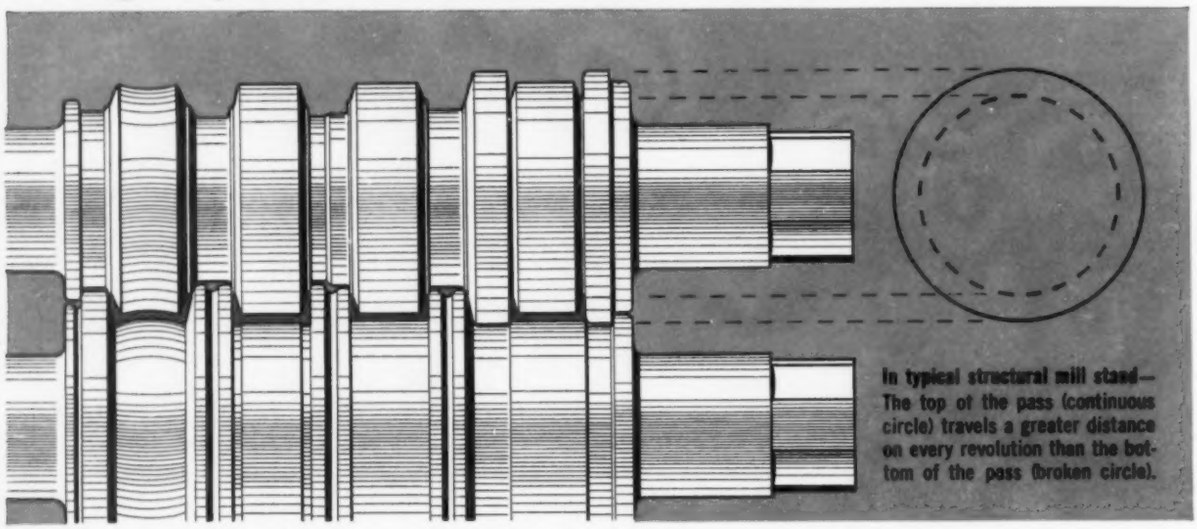

In typical structural mill stand— The top of the pass (continuous circle) travels a greater distance on every revolution than the bottom of the pass (broken circle).

With the large rolls used in beam, channel and other structural mills, excessive side wear in the passes is probably the most common cause of short runs between redressings. The reason, naturally, is the variation in peripheral speed at various pass depths. For example, the top of a typical pass on a 26" diameter roll may travel as much as a foot more on each revolution than the bottom of the pass. The slippage that has to occur aggravates this side wear in the passes.

Thus, structural finishing rolls should be as hard as practical, with the hardness uniform from the surface in. While Mack-Hemp produces several types of rolls widely used in structural mills, the one which offers the best wearing properties—and the one we recommend for all large mills where wear is severe—is the nickel-alloy steel "M-H Midland Supermetal" roll.

The three virtues of nickel—The more carbon in steel, the higher its hardness can be raised by heat treatment. But, carbon also raises brittleness. Strength and resistance to shock and impact suffer.

However, as nickel is added, the strength of the steel increases. Thus, the introduction of nickel raises the permissable level of carbon, since the nickel counterbalances the embrittling effect of the carbon.

Because of its graphitizing property, nickel contributes two other virtues to the "Supermetal" roll. The graphite acts as a lubricant, reducing the rate of wear caused by the slippage in the pass. Secondly, the graphite formed due to the presence of nickel is very fine and well-dispersed, producing a structure that provides a smooth working surface.

The greatest wear resistance—Because of these properties conferred by nickel, Mack-Hemp "Supermetal" represents the best solution yet found to the wear problem created by severe operating conditions in structural mills. However, several other Mack-Hemp roll compositions give excellent results where conditions are less severe. For more detailed information on this—or any other—problem of roll selection, telephone or write us today. There's no obligation.

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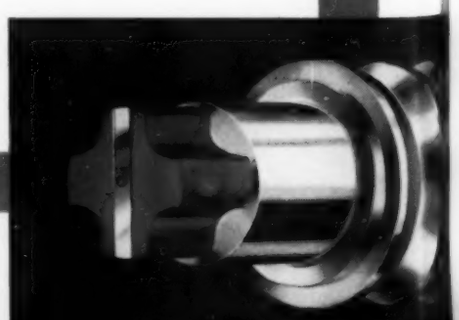
You get more tonnage from the rolls with the Striped Red Wabblers

Division of E. W. BLISS COMPANY

Presses, Rolling Mills, Special Machinery



According to the patent, volatile tin salts are incorporated in the galvanizing charge along with the zinc and the usual flux. Tin chlorides or sodium stannate are the preferred compounds. According to the inventors, the total amount of zinc required to produce a quality product free from uncoated spots and roughness can be reduced as much as 22 per cent by the addition of small amounts of volatile tin salts (about 1 per cent of the weight of zinc).

METHOD FOR SCARFING STEEL

▲ U. S. 2,793,969, issued May 28, 1957 to Ephraim Werner, describes a method for scarfing steel without the use of blowpipes or torches, and without the use of difficult-to-handle chemicals.

The method involves exposing the semi-finished steel shape to oxygen gas or to an atmosphere containing oxygen and an inert gas, while the shape is at the critical ignition temperature of the steel (ranging from 1900 to 2400 F for various types of steel). At this temperature, a layer of iron oxide is formed of such a composition (including FeO, Fe_2O_3, and Fe_3O_4) that its thermal coefficient of cubical expansion is sufficiently less than that of steel to cause the steel upon cooling to separate cleanly from the oxide.

As shown in Figure 3, the process is carried out in an electric furnace 1, having an outer steel casing 2, a high temperature refractory lining 3 forming a hearth 4 in which are mounted silicon carbide glow-bar heating elements 5. In the furnace wall is an opening 6 to receive a refractory plug 7 in which is mounted a thermocouple 8 for recording the hearth temperatures and thus the surface temperatures of the semi-finished steel shape 9. On the hearth bottom 10 are refractory support members 11 for the steel shape 9. In the furnace wall near the hearth bottom is an opening 12 into the hearth, for receiving a gas inlet member 13 for connection to the inert gas source and to the oxygen gas source.

The amount of surface metal removed, including the surface defects, depends on the amount of oxygen introduced. It is necessary to feed oxygen continuously into the furnace while the shape is maintained at the critical ignition temperature.

APPARATUS FOR HEAT TREATING STRIP MATERIAL

▲ U. S. 2,794,630, issued June 4, 1957 to Selas Corp. of America, describes a process and apparatus for placing a thin oxide coating on the surface of strip steel before pickling. Upon pickling, a light surface layer of reduced iron will thus be formed, which provides the optimum condition for producing a tightly adherent tin-plate or galvanizing coating.

As shown in Figure 4, the strip S is passed over a guide roller 1, and moves down through a furnace 2, being heated to an annealing or normalizing temperature (1200 to 1700 F). The strip then passes through a seal 4 and into a cooling chamber 5 filled with a protective atmosphere which will insure that the surface of the strip is bright when it leaves the chamber. The strip leaves the cooling chamber at a temperature below which the desired metallurgical changes have occurred, but above a temperature at which it will oxidize in the atmosphere (750 to 800 F).

The strip leaves the cooling chamber through a roll seal 8, and passes around a pair of guide rollers 9 and 10 in a quench tank 11. Upon leaving the quench tank, the strip goes over a guide roller 12 and through pinch rollers 13, driven by a motor 14, under speed control 15. Water is supplied to the quench tank through pipe 17, and flows out through an outlet 19 having a swivel joint 20 in it, through pipe 21, into drain 22. The level of water in the quench tank may be adjusted by rotation of the hand wheel 25.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Date	Subject	Inventor or Assignee
2,793,693	5/28/57	Take-off equipment for plate shears	United States Steel Corp.
2,793,947	5/28/57	Shelling-resistant rail	United States Steel Corp.
2,793,993	5/28/57	Electrolytic plating of strip metal	Allegheny Ludlum Steel Corp.
2,794,386	6/4/57	Apparatus for baling scrap metal	National Metal & Steel Corp.
2,794,629	6/4/57	Burner support for open hearth furnaces	George P. Reintjes
2,794,728	6/4/57	Impregnation or coating of fine ore particles with carbon	Lesher & Associates, Inc.
2,794,730	6/4/57	Process for rapidly desulphurizing cast iron	Societe d'Electro-Chimie d'Electro-Metallurgie et des Acieries d'Ugine
2,795,409	6/11/57	Open hearth apparatus	Morgan Construction Co.
2,795,487	6/11/57	Production of ammonium sulphate from coke oven gas	Carl Otto
2,795,497	6/11/57	Production of molten iron in a blast furnace	Hans I. Elvander
2,795,519	6/11/57	Production of corrosion resistant spring steel	Sandvikens Jernverks Aktiebolag
2,795,539	6/11/57	Coke quench car	Hughes By-Product Coke Oven Corp.
2,796,125	6/18/57	Flying shears for cutting a running band of steel into portions of predetermined length	Fritz Ungerer
2,796,340	6/18/57	Roasting of iron sulphide ores	The New Jersey Zinc Co.
2,796,373	6/18/57	Method of forming malleabilized iron castings	Aktiebolaget Overums Bruk
2,796,652	6/25/57	Form for casting regenerator checkerwork supports of refractory material	Harry W. Walters
2,796,780	6/25/57	Conveying and cooling apparatus for articles coming from a mill furnace	York Engineering & Construction Co.
2,796,781	6/25/57	Roll adjusting mechanism	The Aetna-Standard Engineering Co.
2,796,995	6/25/57	Door lifting means for horizontal coking chamber ovens	Koppers Co., Inc.
2,797,078	6/25/57	Coil support for annealing furnaces	Augustus A. Straub
2,797,088	6/25/57	Apparatus for continuously centering a moving strip	United States Steel Corp.
2,797,089	6/25/57	Mechanical accumulator in strip feeding devices	United States Steel Corp.
2,797,114	6/25/57	Latching apparatus for coke oven doors	Koppers Co., Inc.
2,797,156	6/25/57	Nitrogen-bearing ferrochromium	Union Carbide & Carbon Corp.
2,797 157	6/25/57	Method of charging containers for reducing ore to sponge metal	Hoeganaes Sponge Iron Corp.
2,797,173 & 2,797,177	6/25/57	Apparatus for annealing and coating steel sheets	John D. Keller

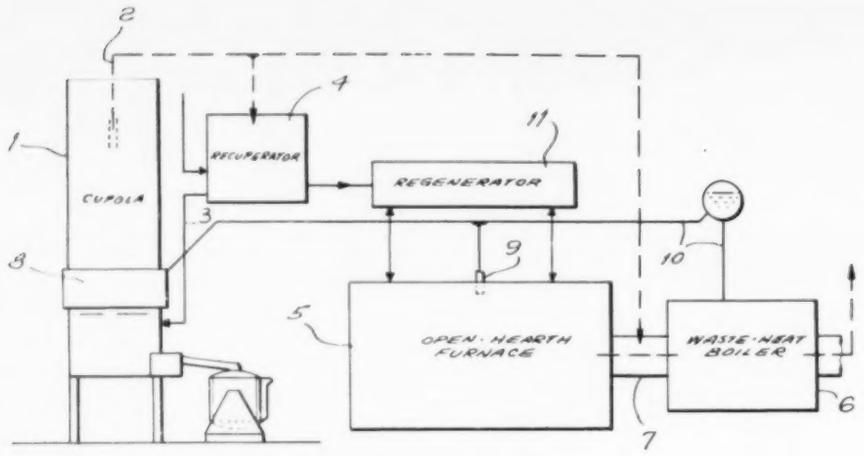


Figure 5

COMBINED STEEL PRODUCING AND HEAT GENERATING APPARATUS

▲ U. S. 2,794,631, issued June 4, 1957 to Ernst Becker and Ernst Lobbecke, relates to an apparatus for generating heat in the use of a steel producing plant, and for using the generated heat in the operation of the steel producing plant.

As shown in Figure 5, there is provided a cupola 1, having a waste gas discharge conduit 2. The cupola operates with a hot air blast introduced by conduit 3. Connected to the waste gas discharge conduit 2 of the cupola is a recuperator 4, for heating the air blast to the cupola.

An open-hearth furnace 5 and a waste-heat boiler 6 are also provided, the boiler 6 being connected to the open-hearth furnace through the waste gas discharge conduit 7 and being connected to the waste gas discharge conduit 2 of the cupola.

Also shown is an arrangement whereby the water-cooling devices used in the cupola and open-hearth furnaces are conducted to the waste-heat boiler 6.

Since the waste gases of the cupola are not fully utilized for the production of the cupola hot blast, they may also be used for preheating the air to the open-hearth furnace, by means of a regenerator 11.

MULTIPLE ROLLER LEVELLERS FOR METAL STRIP

▲ U. S. 2,796,908, issued June 25, 1957 to William D. Shields, assigned to Voss Engineering Co., provides a combination of roller levellers with a payoff reel from which a single sheet of metal is supplied to a slitting machine, and a take-up reel on which several strips are coiled in edge to edge contact.

In Figures 6 and 7, the numeral 1 designates a pay-off reel on which a coil of sheet metal is mounted, the sheet having previously been formed by cold rolling to finished size with a suitable surface finish. The numeral 2 designates a slitting machine having a table 3 and guide rolls 4 and 5, the slitting rolls being designated as 6 and 7. The sheet 1a is slit into four strips 1b. These slits remain in edge to edge relation, and pass down into a looping pit 8, provided with guide rolls 9. Each strip then passes over its own guide roll 10 to a roller leveller (11, 11a, 11b, or 11c). The numerals 12, 12a, and 12b designate guide rolls for the strips passing to a take-up reel 13.

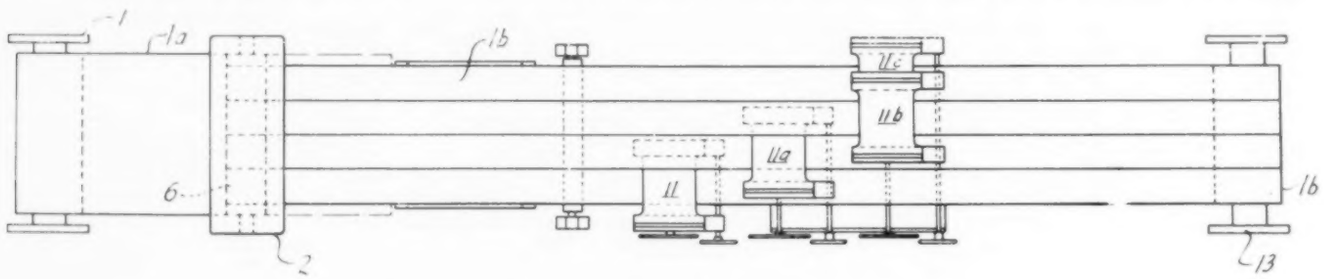
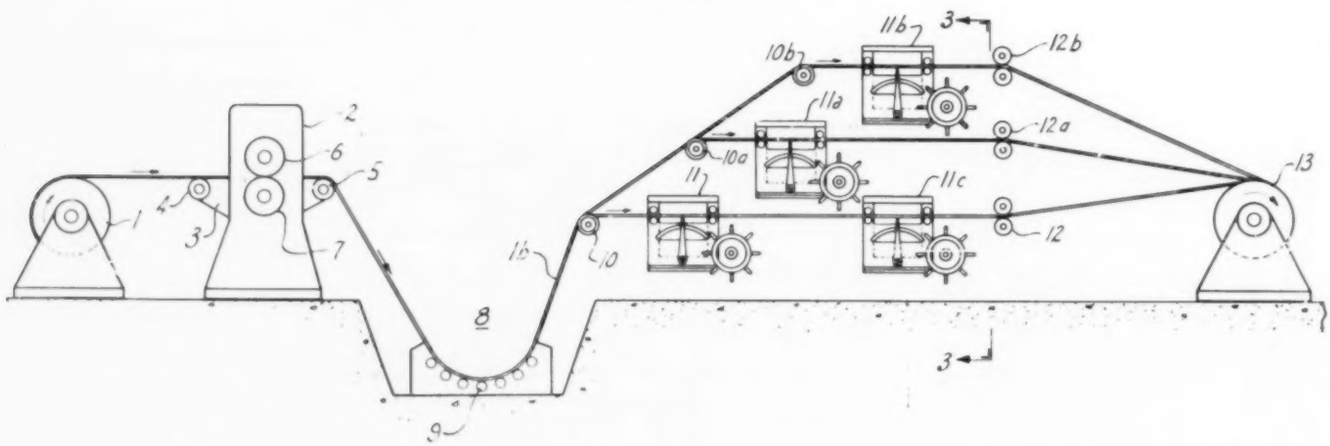


Figure 6

Figure 7



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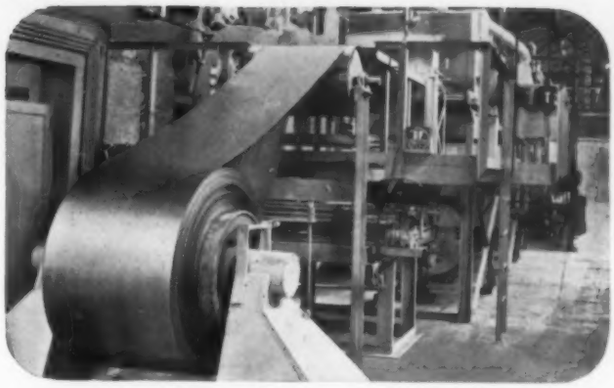
STRIP—ANY PROCESS
SPECIAL ATMOSPHERE TREATMENTS AND OTHER PROCESSING



EF continuous strip line—for annealing, galvanizing, aluminizing, and producing various surface and metallurgical conditions on ferrous and non - ferrous strip.

EF gas fired continuous roller hearth special atmosphere furnace bright annealing long straight lengths of tubing.

EF PRODUCTION FURNACES

for these and other processes

• Reflecting more than 40 years of continuous research, experience and outstanding engineering accomplishments, EF production furnaces combine high heating efficiency—accurate, automatically controlled cycles—high fuel economy—and produce products with uniform physicals and surface finish year after year.

For advanced engineering designs that minimize maintenance and produce high hourly outputs, turn your production furnace problems over to experienced EF furnace engineers—*IT PAYS.*

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GAS FIRED, OIL FIRED AND ELECTRIC FURNACES FOR ANY PROCESS, PRODUCT OR PRODUCTION
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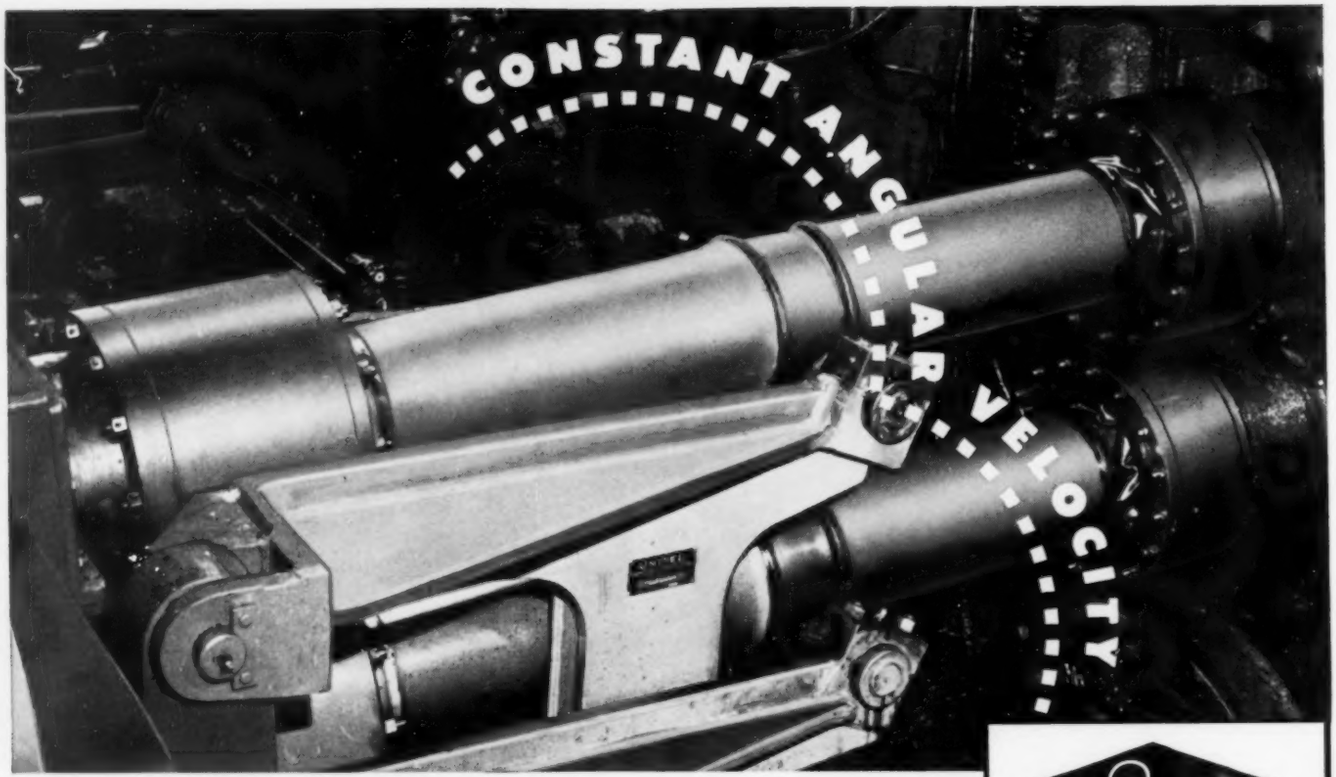
Part of an installation of large EF gas fired three-stack rectangular bell type forced circulation special atmosphere furnaces for annealing steel strip.



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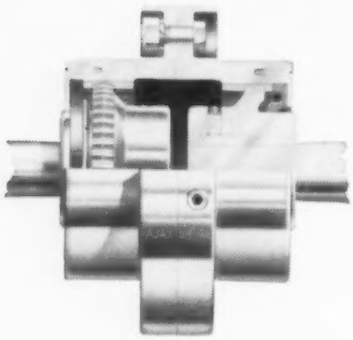
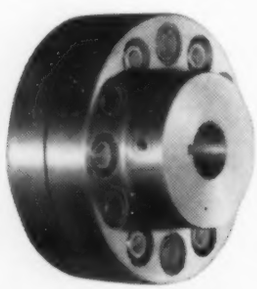


Ajax Dihedral Couplings made in standard, mill motor, floating shaft and spindle types.



Ajax Rubber-Bronze Cushioned Couplings standard of industry for 37 years. Write for catalog.

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Better quality finish, uniform gauge tolerance and long roll life between grinds result from constant angular velocity of Ajax Dihedral Spindle Couplings.

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Smooth operation free from backlash has made possible mill speeds up to 7200 feet per minute.

3 LONGER RUNS

Smooth operation results in longer runs between roll changes. Costly down time greatly reduced — tonnage increased.

4 QUICKER CHANGE OVERS

Self-piloting design of Ajax Dihedral Teeth provides instant lineup between driving and driven gears.

5 TIME TESTED

Hundreds of Ajax Dihedral Couplings have met the severe tests of time and service for 7 years. Learn why it pays to specify Ajax for new equipment and replacement.

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SHELL FORM
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Substation Transformer
100,000 KVA, 3 Phase
With load tap changing equipment. High Voltage: 330,000 Grd Y volts with ±10% regulation in 32 steps of ⅝%. Low Voltage: 14,400Δ volts.
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Pennsylvania builds *Both* types of Power Transformers for Generating Station and Substation Service

With wide experience in both shell form and core form design, Pennsylvania Transformer engineers are able to provide the transformer that is best suited to every application. Full consideration is given to size and weight, ease of installation, impedance, resistance to short circuit stresses, insulation strength, method of cooling, and other characteristics which result in definite advantages in a given kva and voltage for one design or the other. **Core form or shell form?** Why not let the answer for your next transformer be based on Pennsylvania's proved principles of power transformer design? Pennsylvania Transformer Division, McGraw-Edison Company, Canonsburg, Pa.

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PENNSYLVANIA POWER TRANSFORMERS

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It's not hard to see why. Pick up any Obround Condulet, for example, and note such features as these:

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WEDGE NUT COVER FASTENER: This exclusive Crouse-Hinds feature is part of the cover itself. Screws can't fall out. No screw holes to locate. No protruding screw hole ears to damage cable.

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There is a type for every need, including a wide selection of interchangeable covers and wiring devices. Just call your Crouse-Hinds distributor and ask for "Condulets!"

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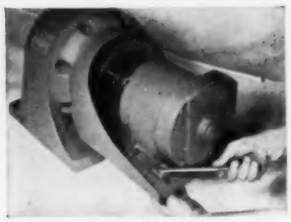

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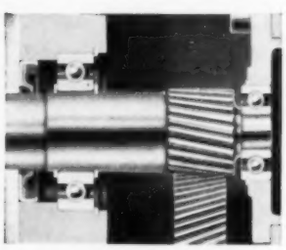

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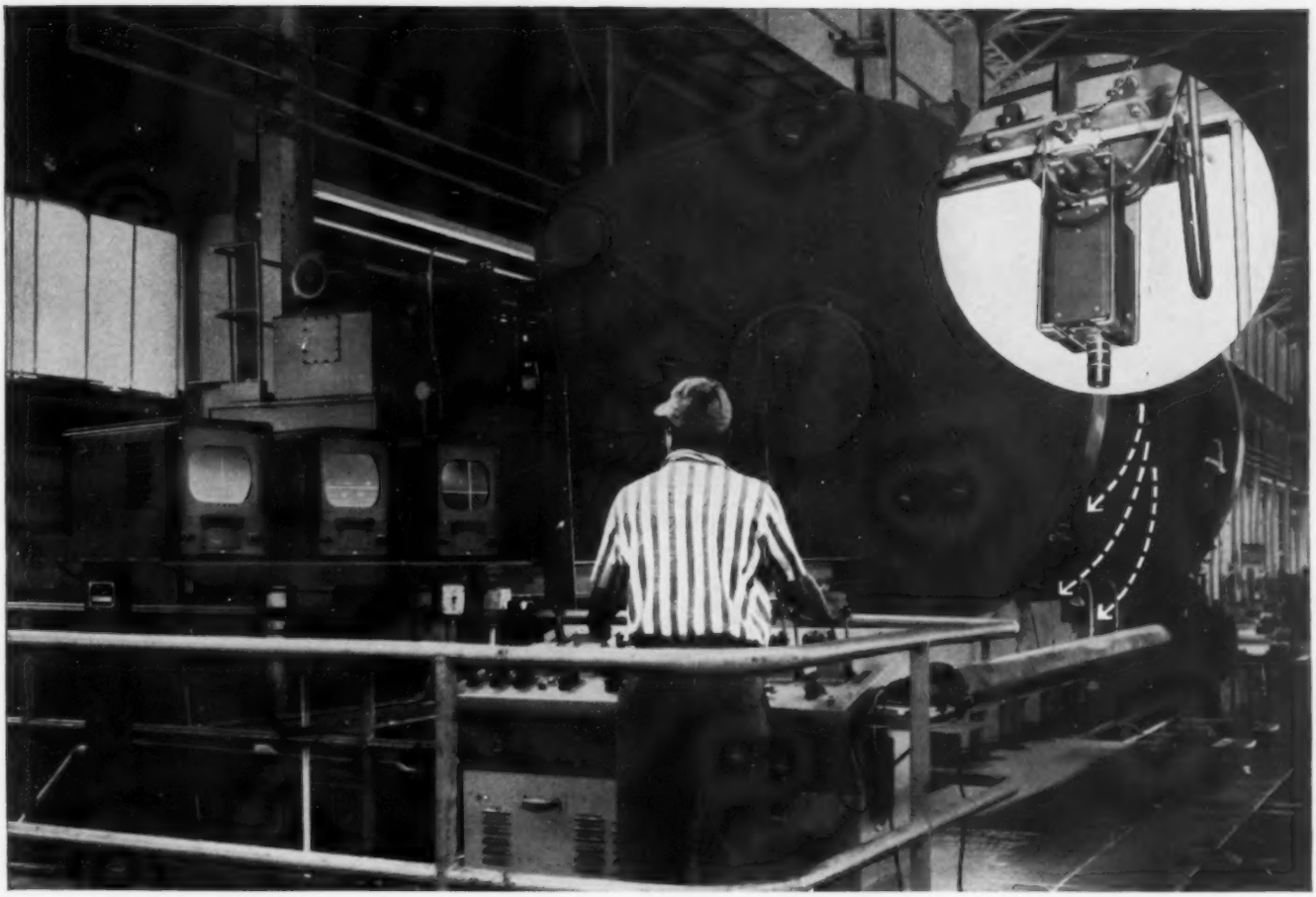

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Here's a unit substation transformer that you can safely install in any load center—any place—no matter how tough the operating condition.

Wagner Sealed Dry-Type Transformers are hermetically sealed in a welded steel case to provide positive protection from contamination, fire and explosion hazards.

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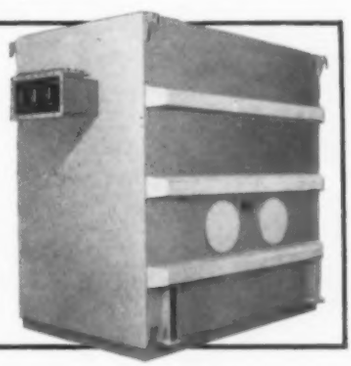

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TSP Sheave Wheels have increased cable life 8 to 12 times. These cables running on competitive sheaves wore out every month. Dollar savings alone are outstanding.

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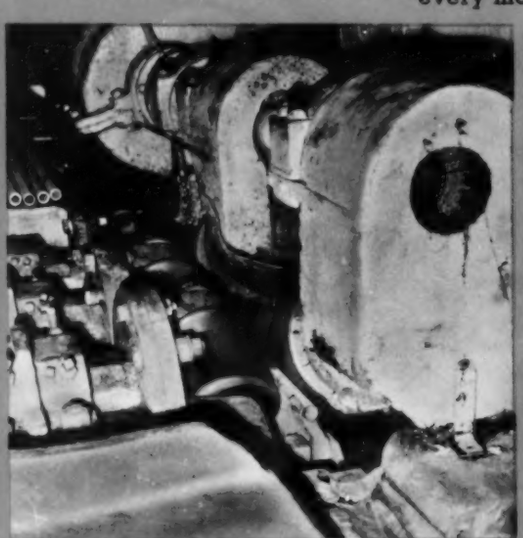
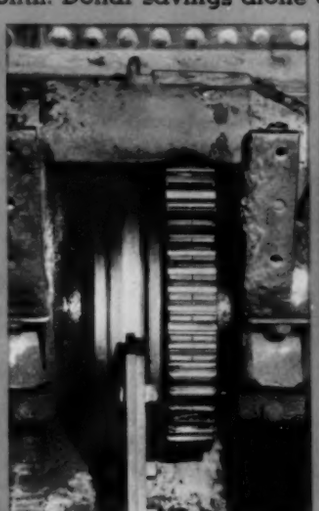
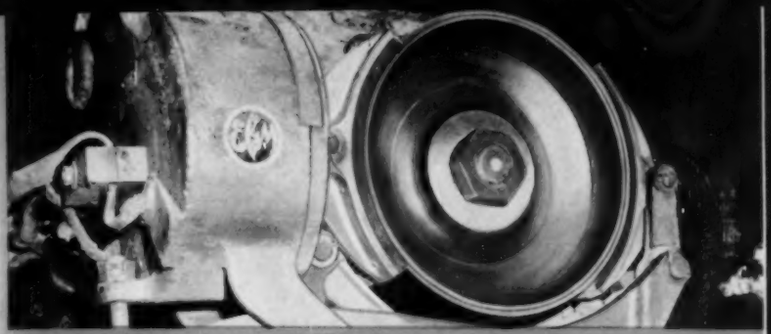


TSP Rolls on Sutton Straighteners give longer life and are used exclusively by Laclede Steel.

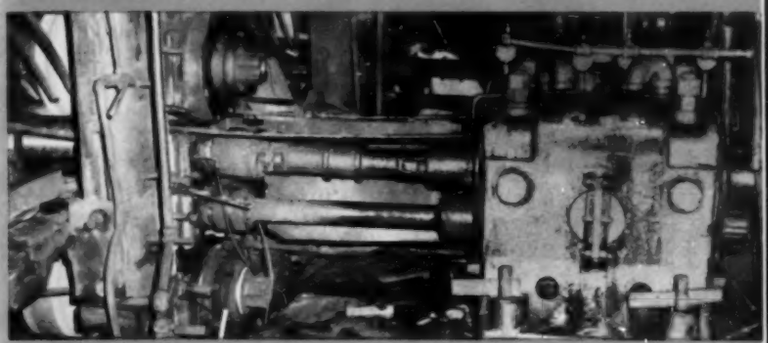


TSP Wheels, Gears, Axles, showing practically no wear after years of service.

TSP Screw-down Screw on Ingot Mold Stripper Crane outlasts competitive screws many times.



TSP Hoist Brake Wheel on Ingot Mold Stripper Crane was installed in 1946, shows hardly any wear. Competitive wheels formerly used lasted only a few months. TSP wheels now used exclusively. Brake linings are also lasting 2 to 3 times longer.



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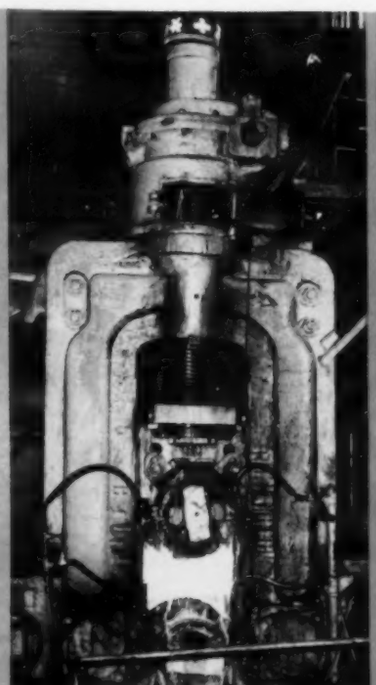
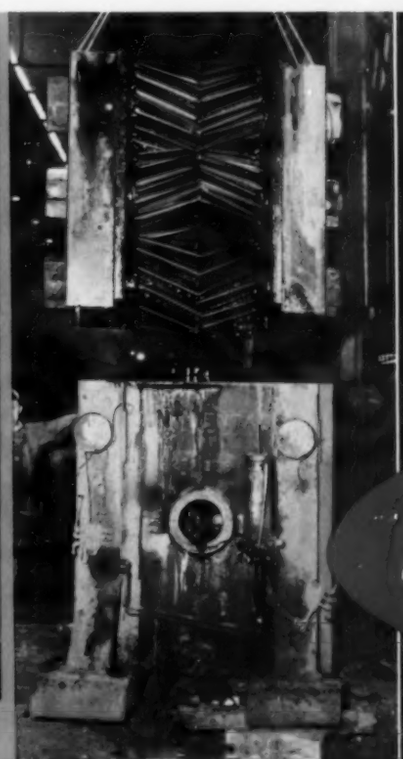


TSP SCREW-down Screws and Nuts on 35" Blooming Mill replaced original competitive screws and nuts. Since replacement only TSP screws and nuts have been used.



TSP Herringbone Pinions on Bar Mill give many times the life of competitive pinions.

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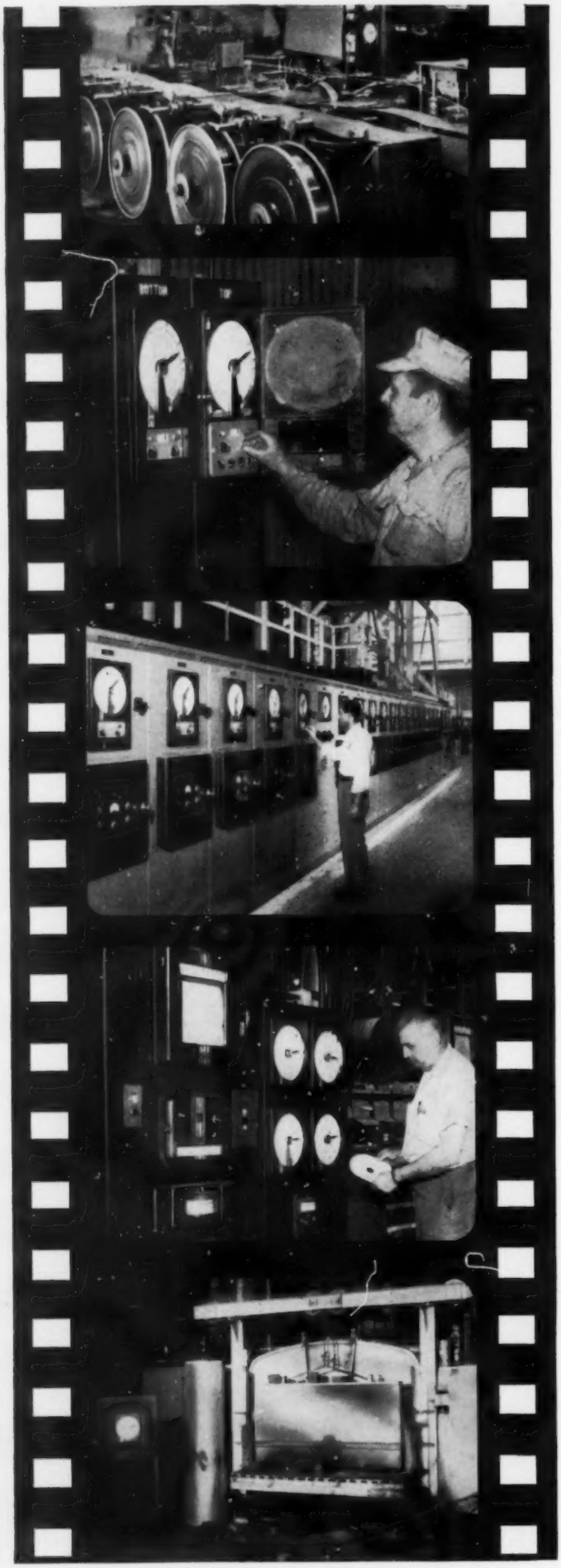

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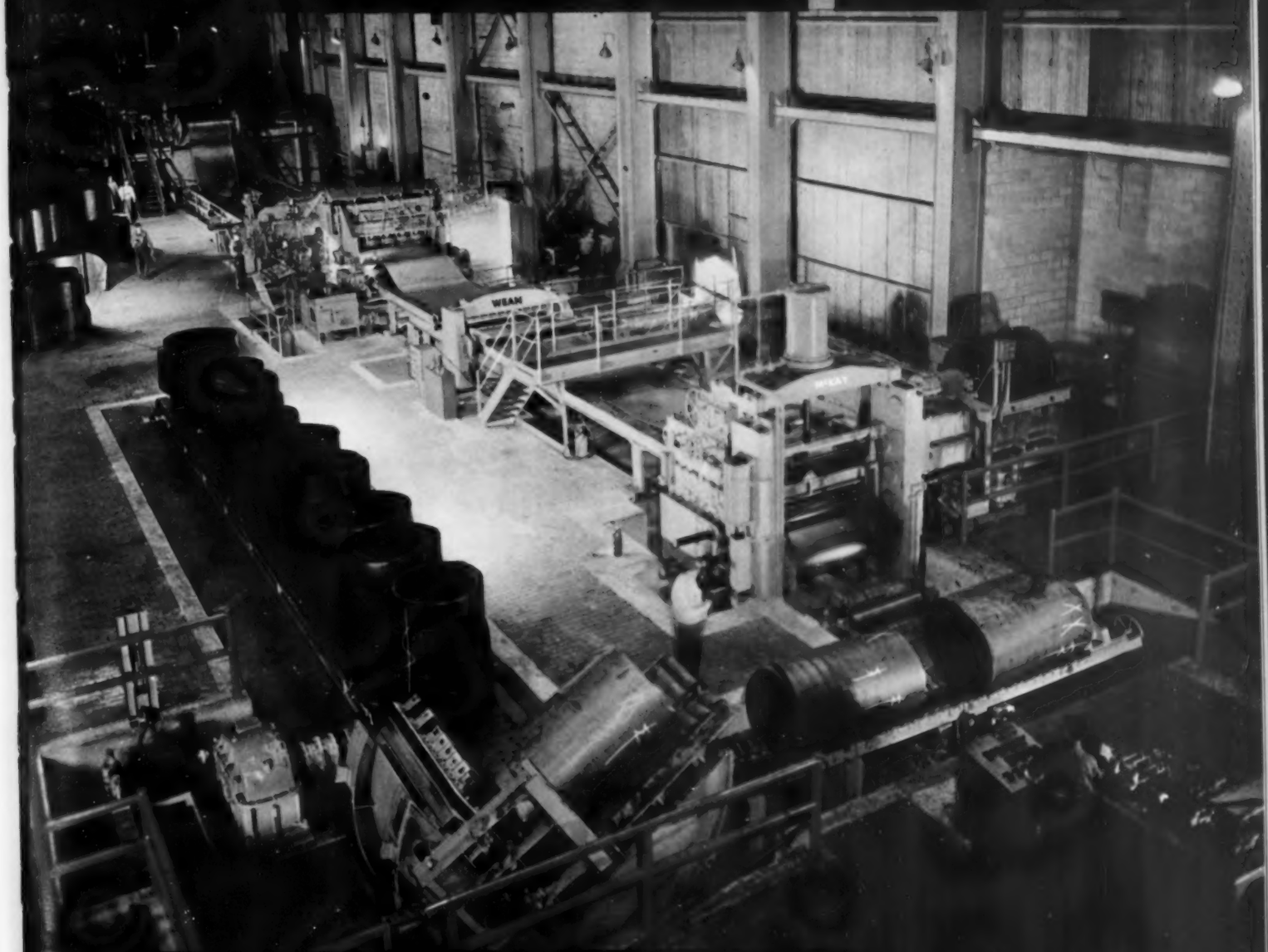

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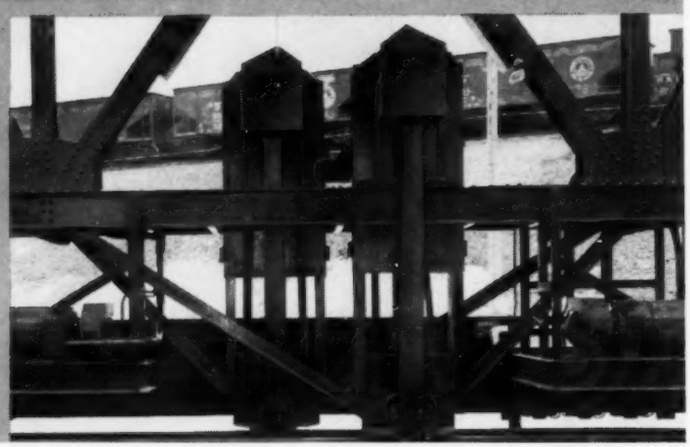

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keep ore bridges safe in winds above 100 mph

Dravo Automatic Rail Clamps give positive protection from high winds to travelling bridges and unloaders. Action is automatic and no adjustments are necessary. This extra margin of safety and convenience is but one example of the advantages found in Dravo bulk materials handling equipment. Each structure is individually designed to handle each specific job economically and safely. Such performance is achieved by bringing together the customer's operating knowledge and the experience of Dravo's research, design and construction men.

This method has resulted in high efficiency bulk materials handling equipment that produce because they are tailored to fit the job. Dravo engineering features, built into every structure, provide for low maintenance and operating costs. For complete information on ore bridges or unloaders, write to Dravo Corporation, Pittsburgh 25, Pennsylvania.

DRAVO
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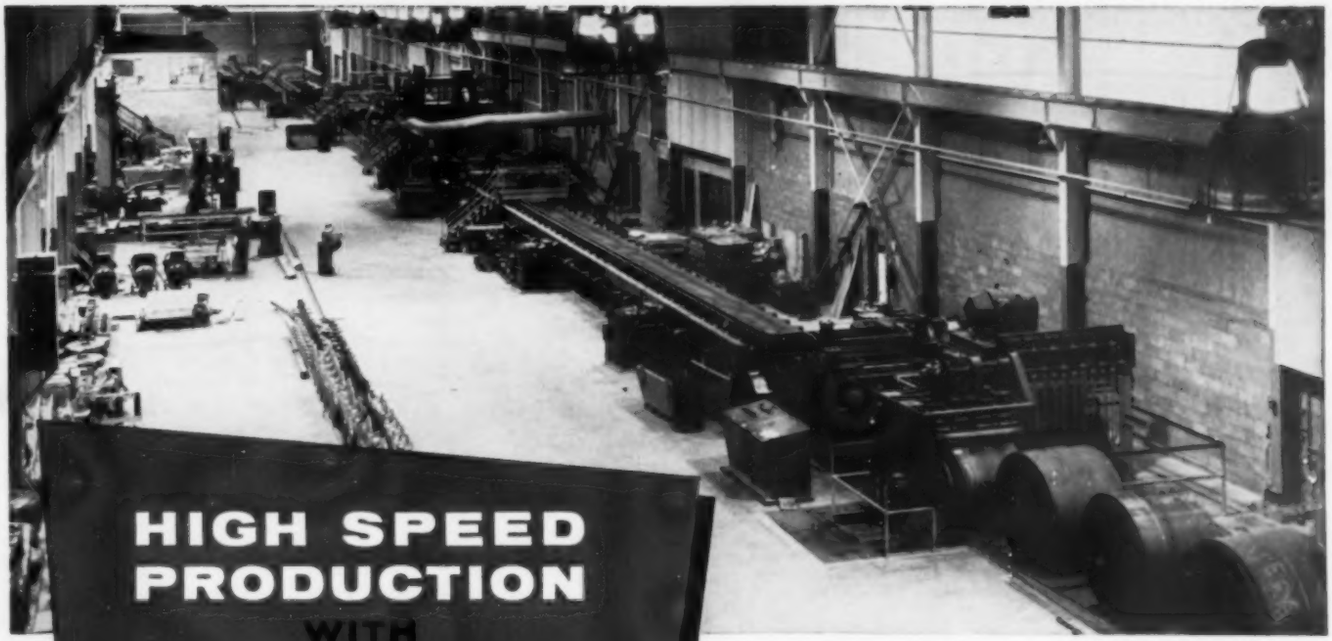
Blast furnace blowers • boiler and power plants • bridge sub-structures • cab conditioners • docks and unloaders • dredging • fabricated piping foundations • gantry and floating cranes • gas and oil pumping stations • locks and dams • ore and coal bridges • process equipment • pumphouses and intakes • river sand and gravel • sintering plants • slopes, shafts, tunnels • space heaters • steel grating • towboats, barges, river transportation



Six Reliance V★S Drives make it possible to operate this complete line as if it were a single machine.

Carloads of pipe are pouring out of the new Edmonton, Alberta plant of Alberta Phoenix Tube & Pipe, Ltd. This $6.5 million installation is producing pipe at unprecedented rates.

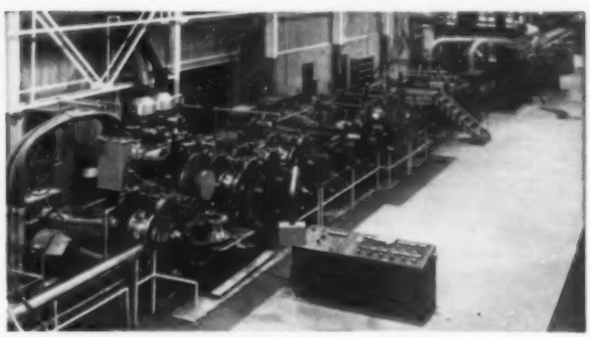
Volume pipe production requires something special in a drive system—one that furnishes precise speed control and instantaneous motor response. A wide stepless range of speeds is provided to handle various pipe diameters and lengths, and all sections of the line operate at the same relative speed.

A team of Reliance Application Engineers, working with the machinery builder, built this specialized drive. This team knows the processes of the steel industry and how to handle the problems involved. Engineering knowledge, backed by the quality of Reliance products, supplied this accurate, simple-to-operate, economical drive.

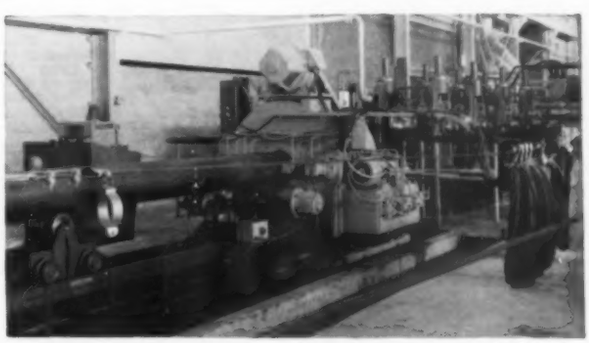
The Reliance Application Engineering Department builds drives for every industry. A team of engineers who are experts on your industry's operation, stand ready to engineer and build the drive for your particular needs.

If you would like more information on this installation, write for Bulletin L-2505.

L-1541



The welding section operator controls the speed of the entire line from this Reliance Pendent Station.

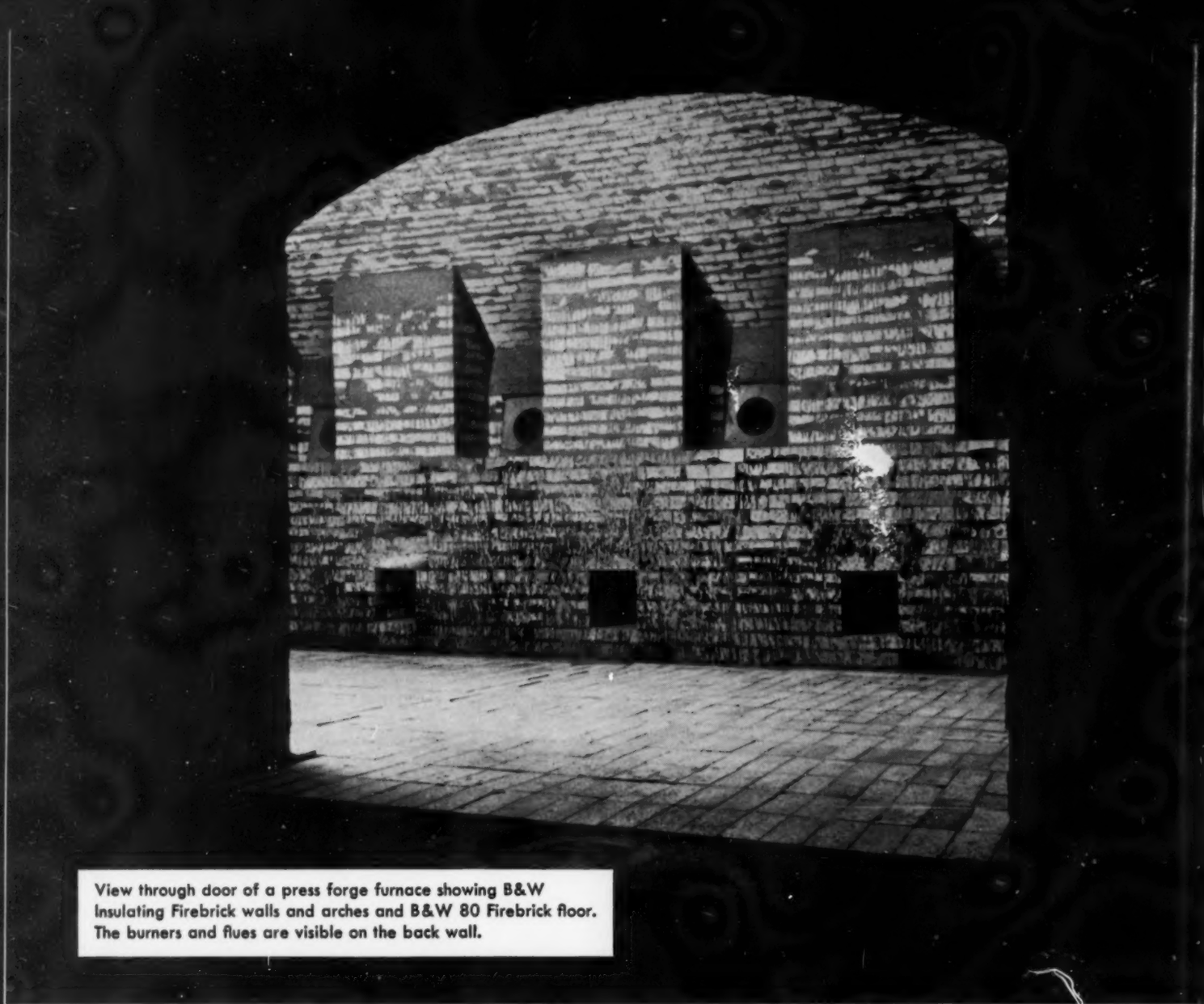


The Reliance V★S Drive on this flying cutoff automatically measures the pipe and controls the movement and speed of the carriage.

RELIANCE ELECTRIC AND ENGINEERING CO.

DEPT. 1111A CLEVELAND 17, OHIO • CANDIAN DIVISION: WELLAND, ONTARIO

Sales Offices and Distributors in Principal Cities



View through door of a press forge furnace showing B&W Insulating Firebrick walls and arches and B&W 80 Firebrick floor. The burners and flues are visible on the back wall.

B&W Insulating Firebrick reduce fuel costs 15% and increase production

Experience paid off for this major steel producer. Aware of the benefits of B&W Insulating Firebrick in his drop forge furnaces, he built two new press forge furnaces with lightweight B&W IFB linings. The results were a minimum average fuel saving of 15% *and* increased production, since the entire heating process for certain grades of steel could now be accomplished in one operation. Here's why.

The lightweight and consequent low heat storage of B&W IFB linings keep the furnace walls at a uniform temperature to provide the most efficient heating conditions. Unlike heavier constructions, B&W Insulating Firebrick linings attain a uniform temperature faster with less fuel consumption.

In addition, B&W IFB linings respond quicker to temperature changes, permitting more accurate temperature control. In this instance, this not only prevented the cracking of tool and stainless steels, but helped reduce the total heating cycle, increasing production.

These forging furnaces use a 9" B&W K-30 IFB wall backed up by B&W K-20 IFB. The K-30 is used as face brick because of its high temperature resistance. The K-20 is used as a backing because of its high insulating value. The hearth floor is of B&W 80 Firebrick for abrasion resistance and resistance against attack by mill-scale at the temperatures involved. Door linings are of B&W Kaocast and B&W Kaolite. R-583

B&W REFRACTORIES PRODUCTS: B&W Allmul Firebrick • B&W 80 Firebrick • B&W Junior Firebrick • B&W Insulating Firebrick • B&W Refractory Castables, Plastics, and Mortars • B&W Silicon Carbide • B&W Ramming Mixes

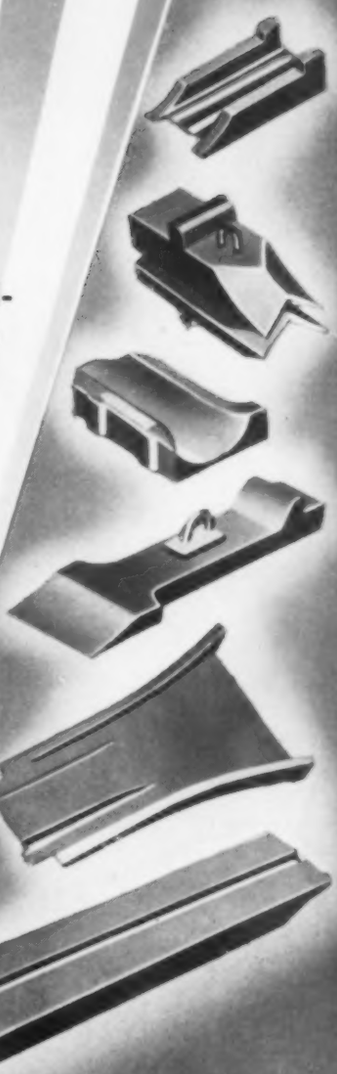
BABCOCK & WILCOX
THE BABCOCK & WILCOX CO.
REFRACTORIES DIVISION
GENERAL OFFICES: 161 EAST 42nd ST., NEW YORK 17, N.Y.
WORKS: AUGUSTA, GA.

TRANTINYL

GUIDES THE STEEL INDUSTRY

"TRANTINYL" offers a quarter-century of metallurgical experience. "TRANTINYL" patented alloys were developed to function in specific operations where guides are required to resist wear and abrasion. Users of "TRANTINYL" alloys are astounded at the tonnage rolled over one set of guides.

Join the many satisfied users of "TRANTINYL."



ROLLING MILLS:
bar, hoop, strip, shape mill guides; and rollers.

SEAMLESS TUBE MILLS:
guide shoes, rolling mill plugs and rolls, piercer points, etc.

ELECTRIC WELD TUBE MILL:
forming rolls, planishing rolls, tool holders, etc.

STRAIGHTENING MACHINE GUIDES

HEAT RESISTING CASTINGS

"TRANTINYL No. 1" CAST TO SHAPE

Youngstown Alloy Casting Corporation

Youngstown, Ohio

New Westinghouse All-Steel Panel for Mill Control

Non-breakable, easily installed, extra-safe DC mill control panel offers a new standard for steel mill performance

New all-steel d-c mill control panels will not break or crack under the most severe physical shock. At least 35 percent lighter in weight than other panel material, can be handled easier . . . installed faster.

Extra-safe, unbreakable, non-carbonizing insulating bushings have fiber glass base with alkyd resin blinder for greater shock resistance. Design gives ample creepage distances, superior anti-tracking qualities . . . prevents build-up of dust on bushing.

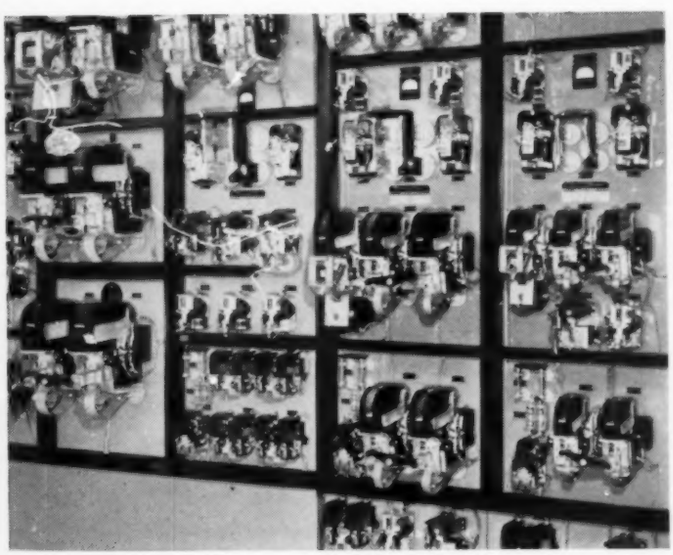
Control wiring in non-inflammable Micarta® channels with snap-off covers provides for easier wiring, tracing, inspection or repair. Stranded wire, highly resistant to vibration, is permanently marked with easy-to-read terminal marking.

Time-Proven Devices are heavy duty, rugged and liberally rated to give longer life for heavy steel mill service.

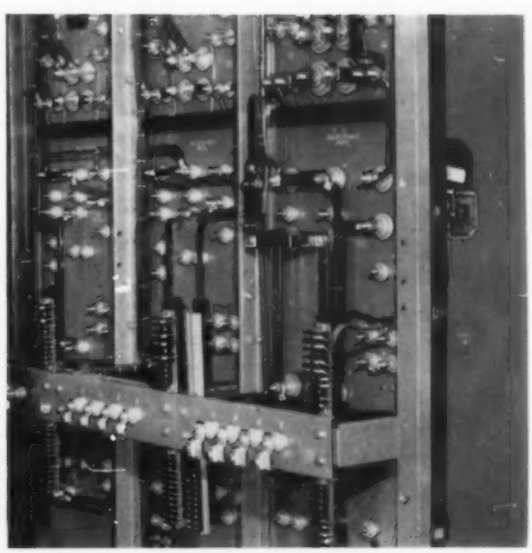
For more information about the new all-steel panel, call your Westinghouse sales engineer. Or write, Westinghouse Electric Corporation, P.O. Box 868, 3 Gateway Center, Pittsburgh 30, Pa.

J-22069

YOU CAN BE SURE...IF IT'S Westinghouse

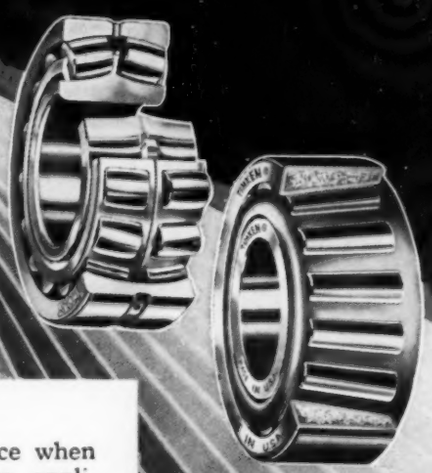


Bonderized light-grey finish of new Westinghouse all-steel panel brightens up entire control panel area — makes all external components easier to see, easier to inspect.



Maximum accessibility is offered with main connections in rear of new steel panel . . . gives more liberal spacing between leads since all control wiring has been removed from rear.

IT TAKES ONLY 5 MINUTES, 37 SECONDS



One reason why you can always be sure of fast service when you order bearings, bearing specialties, and transmission appliances from Berry Bearing Company is--it takes only 5 minutes and 37 seconds to fill your order. In other words, in less than 6 minutes after you phone your order in--it is being placed in the delivery car, ready to head your way.

But, fast order processing is only one of the reasons why Berry Bearing is famous for--IMMEDIATE DELIVERY. As authorized stock carrying distributor for 41 of the nation's leading manufacturers of bearings, bearing specialties, and transmission appliances--Berry has one of the largest inventories in the United States to draw from. Over 50,000 items are regularly carried in stock.

So, for *anything*...and...*everything* you need--phone Berry. You can bank on immediate delivery on every order, large or small.

BERRY BEARING COMPANY

All phones--DAnube 6-6800

2633 S. Michigan Ave. Chicago 16, Illinois

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from cold strip to finished tubing
IN SECONDS!
with a YODER
ELECTRIC-WELD TUBE MILL

One of the fastest . . . and one of the least expensive . . . methods of making steel tubing is with a Yoder Electric-Weld Tube Mill. The Yoder method eliminates the need for time-consuming heat treatments and costly conditioning furnaces for most tube needs. Scrap losses, too, are far lower than any other method . . . usually less than 2%.

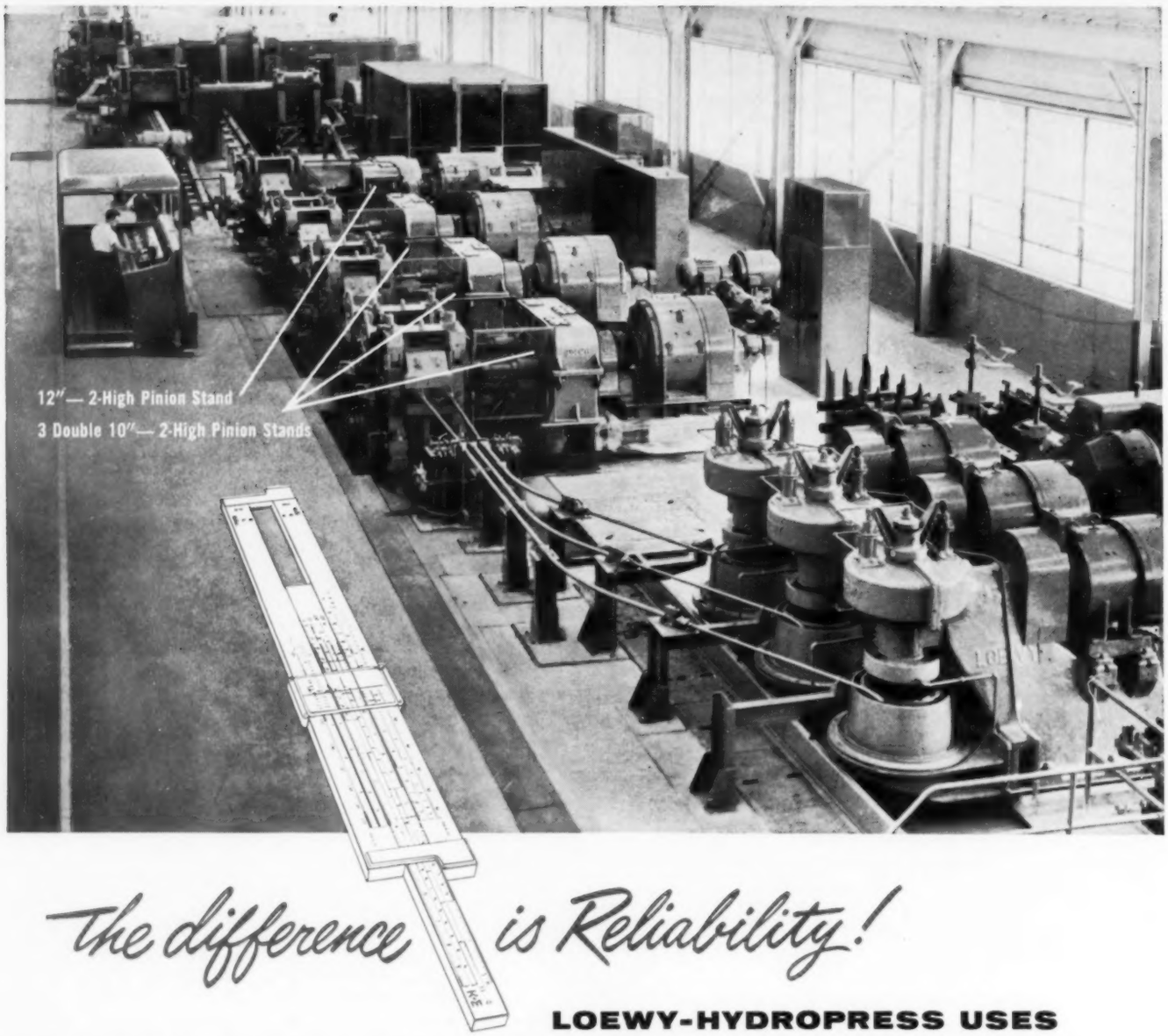
The Yoder Type-M Mill shown above is operated by one man and a helper. Coiled strip on this mill is continuously cold-roll formed, welded and cut to required lengths in a matter of seconds . . . at speeds up to 340 f.p.m. The quality of the resulting tube is *constantly* better than the requirements of commercial standards. This is one of many reasons why manufacturers and users of tubing the world over are using more Yoder mills than all other makes combined.

If your business requires pipe and tubing, ferrous or non-ferrous, in sizes from ¼-inch to 26-inch diameter, Yoder can supply the engineering service and machines to produce it faster and better for less! For complete details, write for the Yoder Tube Mill Manual. It's yours for the asking.

THE YODER COMPANY
5495 Walworth Avenue • Cleveland 2, Ohio

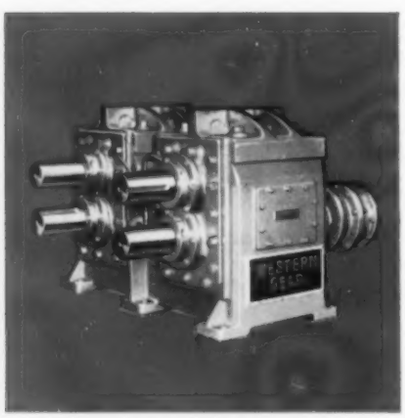
ENGINEERING **YODER** MANUFACTURING

PIPE AND TUBE MILLS (ferrous or non-ferrous)
COLD ROLL FORMING MACHINES
ROTARY SLITTING LINES



The difference is Reliability!

LOEWY-HYDROPRESS USES WESTERN GEAR PINION STANDS FOR NEW COPPER WIRE ROD MILL



Typical Western Gear pinion stand, available in capacities to 2000 HP.

When the Loewy-Hydropress division of Baldwin-Lima-Hamilton Corporation designed and built an important installation for a leading manufacturer of electric cable, they selected Western Gear pinion stands. Company engineers knew that our years of experience and service to the steel industry would result in units engineered to suit the specific requirements of power and speed, type and gauge of metal, nature of load, and type of drive motor. Western Gear pinion stand designs incorporate special "Hy-Q"* precision gears and pinions, liberal size shafts, conservatively selected anti-friction bearings, and rigidly constructed gear cases in order to insure dependable trouble-free operation.

So, if yours is a project involving modernization or the construction of a new mill, ask Western Gear specialists to help you. You'll get the benefit of mechanical power transmission experience gained since 1888 to help solve your problem, efficiently and economically. Address General Offices, Western Gear, P.O. Box 182, Lynwood, California.

*T.M. REG.

"The difference is reliability" • *Since 1888*

PLANTS AT LYNWOOD, PASADENA, BELMONT, SAN FRANCISCO (CALIF.)
SEATTLE AND HOUSTON—REPRESENTATIVES IN PRINCIPAL CITIES

WESTERN GEAR *Corporation*
ENGINEERS AND MANUFACTURERS

New Taylor Volumetric Differential Pressure Transmitter

. . . ELIMINATES ~~PURGE~~ AND ~~SEAL~~ PROBLEMS ECONOMICALLY!

Ideal for these difficult flow and liquid level measurements:

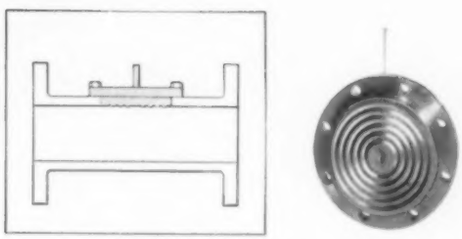
- Slurries
- Corrosive liquids
- Colloidal suspensions
- Fluids that jell when not in motion

The new Taylor Volumetric Differential Pressure Transmitter is completely isolated from the process material. Thus it never has to be purged of deposited material, never suffers from corrosion. The pressure-sensitive diaphragms may be installed flush with the inside of the pipe or tank in a variety of mountings. The temperature limit is 300° F. at the diaphragms. Pressure limit of the instrument is 1500 lbs., and the system is limited only by the flange rating on the primary side.

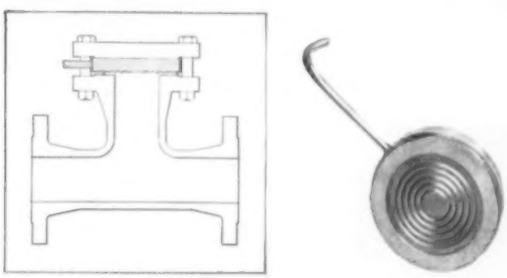
This instrument is a modification of the familiar Taylor 333RD differential pressure transmitter, and is just as accurate, sturdy and dependable.

For full details about this new instrument, ask your Taylor Field Engineer, or write for **Bulletin 98281.**

Taylor Instrument Companies, Rochester, N. Y., and Toronto, Canada.



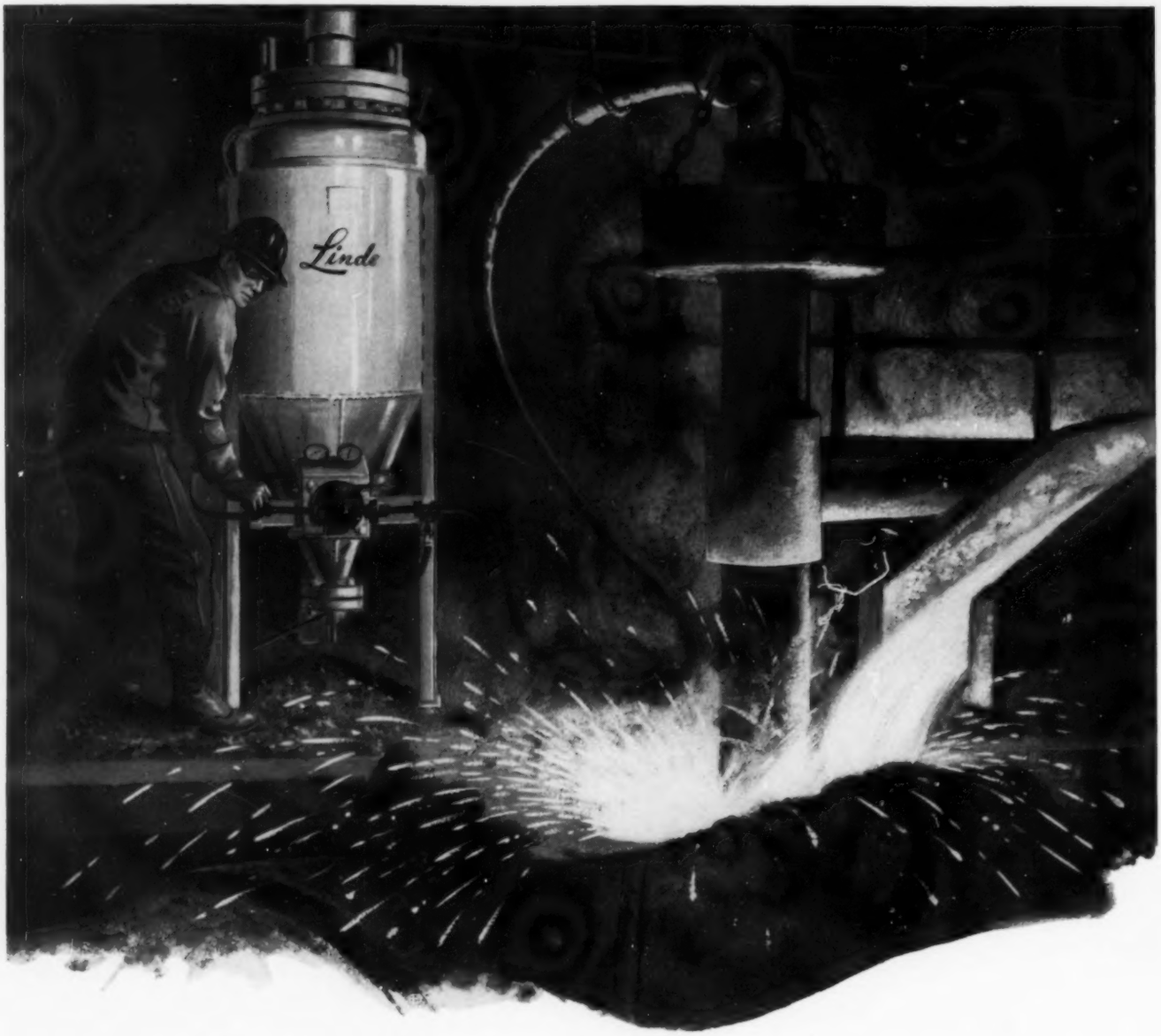
Type 95 flange (*right*), for use with chemical tee. For flow installations where diaphragm is flush with the inside of pipe, so that process fluid imparts a scouring action. Also for liquid level requiring flush installation. Maximum pressure 300 psi.



Wafer type sensing element (*above*), for use with standard 3" ASA flange, where diaphragm need not be flush mounted, e.g., corrosive flow or liquid level measurement. Standard diaphragm material, for both types, 316 Stainless Steel; alternates available. Maximum pressure 1500 psi.

Taylor Instruments
MEAN
ACCURACY FIRST

VISION · INGENUITY · DEPENDABILITY



LINDE's method for desulphurization of iron at the blast furnace is simple, efficient, and economical. Principal units are nitrogen supply, dispenser, and injection tube.

MAKE OFF-CASTS MEET SPECIFICATIONS . . . WITH

Metallurgical Carbide from LINDE

With LINDE equipment and UNION calcium carbide, the sulphur content of molten pig iron can be effectively and economically reduced. When you use the LINDE method, you get these advantages: No noxious fumes . . . dry slag does not attack refractory materials . . . treatment is fast, easy to operate and control . . . results are predictable and uniform.

The LINDE equipment includes a large carbide dispenser, adequate nitrogen supply, and graphite injection tube. Fine mesh carbide, carried by a stream of pressurized nitrogen, is injected deep in the hot metal. Using this LINDE method, you eliminate unnecessary pigging costs. And you can gain even greater savings by buying metallurgical carbide in bulk from LINDE.

If you would like to know more about LINDE's improved desulphurization methods and equipment, write today. LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y. Offices in other principal cities. *In Canada:* Linde Company, Division of Union Carbide Canada Limited.

Linde
TRADE-MARK

UNION CARBIDE

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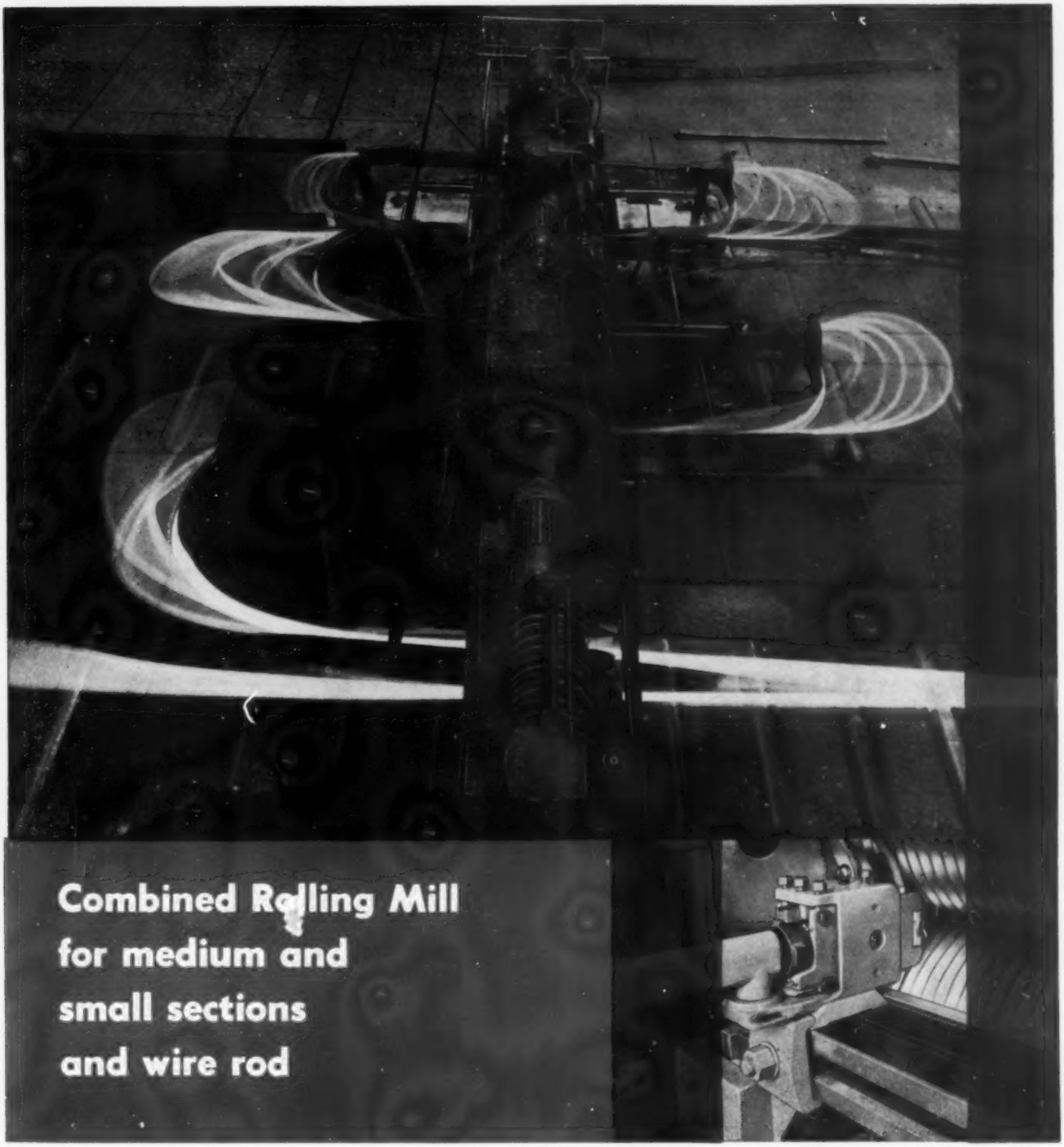


Roller guide No. 60

Rolling with repeaters in a 19,3—21,6 in. 3-high train of MORGÅRDSHAMMARS combined medium section, small section and wire rod mill.

Our production schedule includes complete mechanical equipment for the combined rolling mill.

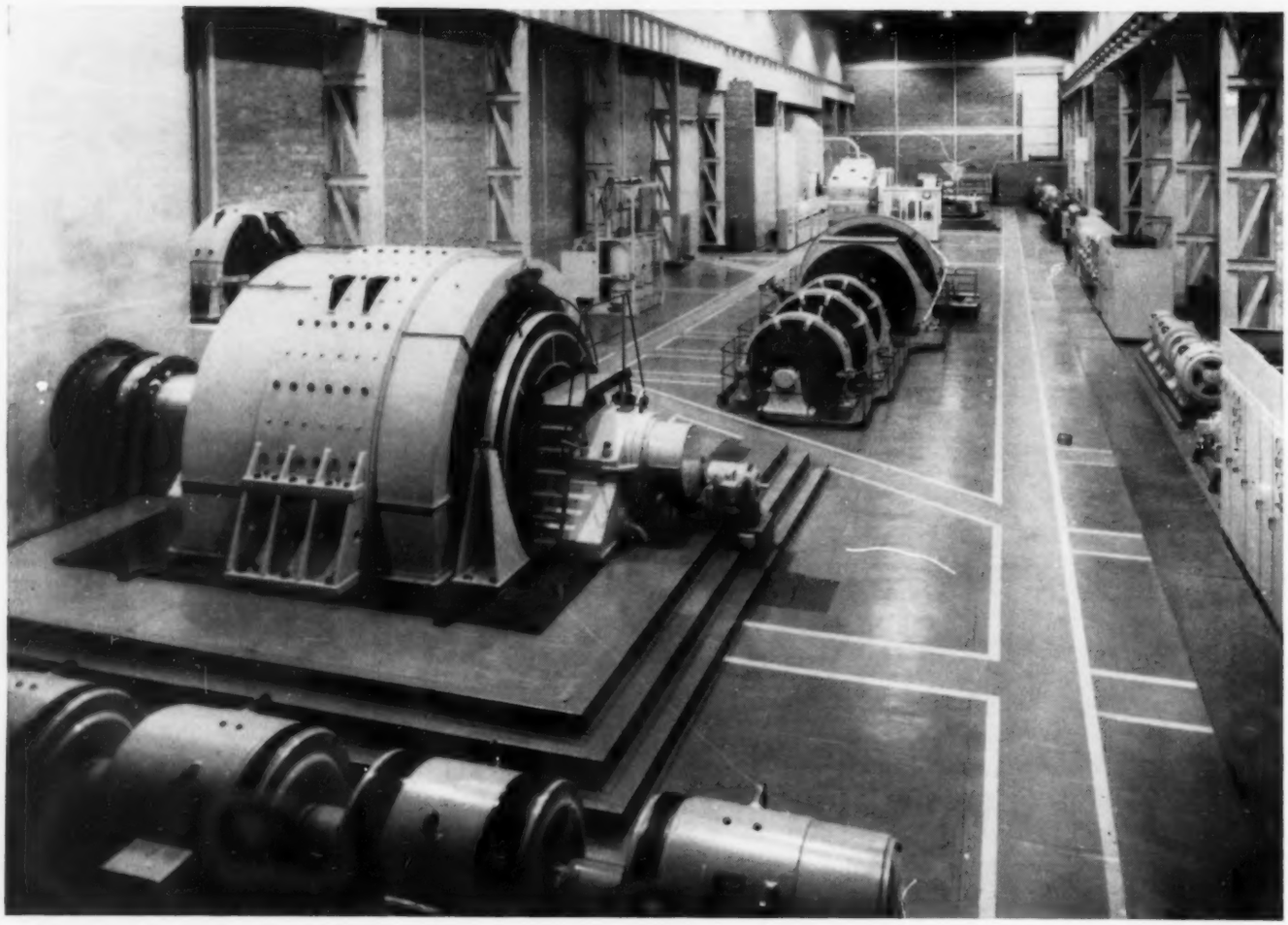
For further information, please apply to us for reprints from the Journal of Iron & Steel Institute.

Swedish quality

MORGÅRDSHAMMAR

MORGÅRDSHAMMARS MEK VERKSTADS AB • MORGÅRDSHAMMAR

SWEDEN



COMPLETE STEELWORKS ELECTRIFICATION

Complete projects are a specialty of English Electric. The typical example illustrated here shows the motor room of a modern steelworks. It contains a 7000 H.P. reversing plate mill drive with Ilgner set; a 1250 H.P. edger drive, scale breaker, and broadside mill drives of 1000, 1500 and 3500 H.P. These drives and the associated equipment were designed and built by English Electric.

If you are planning a complete steelworks electrification, or simply the addition for a small auxiliary drive, give us a call at any district office or write direct to our Metal Industries Division in St. Catharines or The English Electric Export and Trading Company Limited, Beaver Street, New York, N. Y. Our extensive experience is at your disposal.

'ENGLISH ELECTRIC' DIRECT CURRENT DRIVES

ENGLISH ELECTRIC COMPANY OF CANADA, LIMITED, ST. CATHARINES, ONT.
VANCOUVER, EDMONTON, CALGARY WINNIPEG, TORONTO, OTTAWA, MONTREAL AND HALIFAX

PA-5774

Generator brushes wearing rapidly?

Call your NATIONAL brush man...

TRADE-MARK

Here's how he helped one steel mill increase brush life 400%

FLOYD ANDERSON

Six-month brush life was the most this eastern steel mill could coax out of its 1500 kw generator. The result, reports "National" Carbon Brush Man, Floyd Anderson, was frequent down time plus some mighty expensive *extras*.

Rapid wear, film stripping, threading and grooving resulted in frequent stoning and excessive maintenance cost.

Floyd analyzed the generator's work load and recommended "National" carbon brushes, grade N-4. Brush wear was reduced immediately. N-4 brushes are averaging two years' service on this generator — a 400% improvement.

Floyd Anderson and his fellow "National" Carbon Brush Men have been solving industrial brush problems for years. Their experience and training — backed by "National" *long term brush development* — make them the logical consultants on any industrial brush application.

Call them today or write National Carbon Company, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, N. Y.

UNION CARBIDE

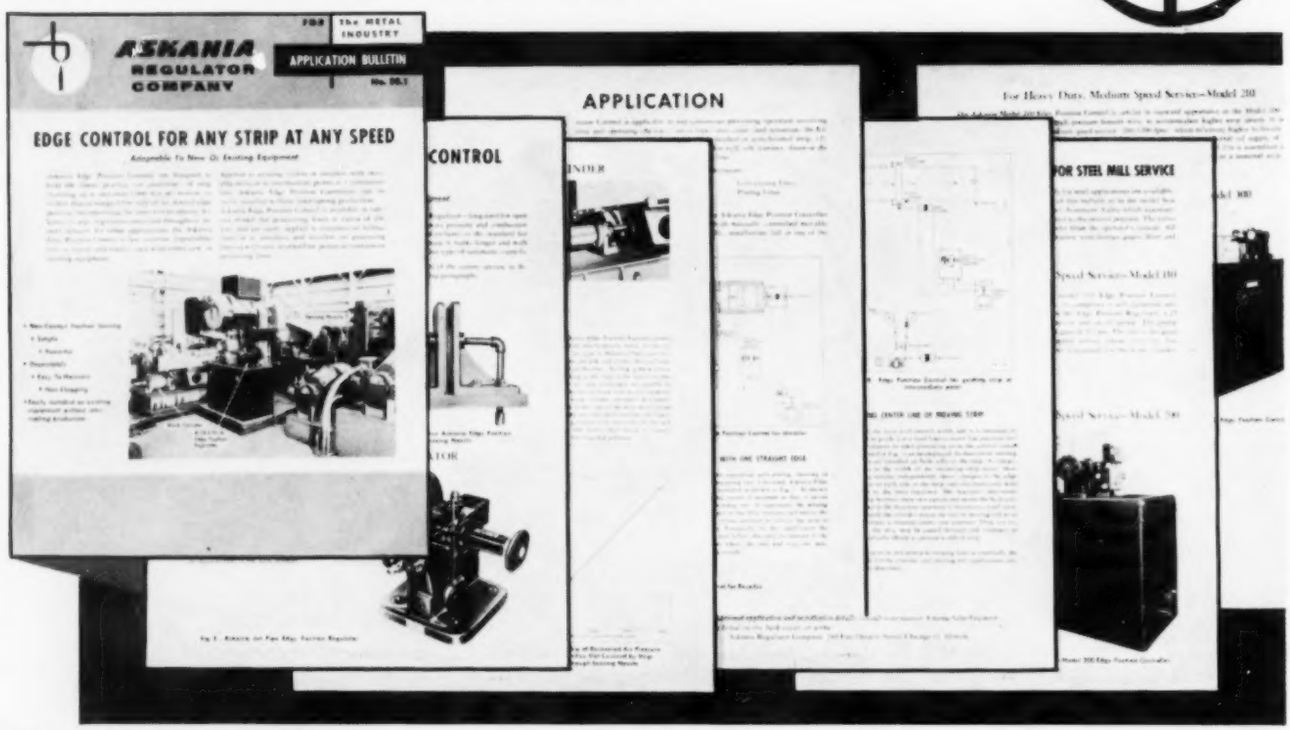
The terms "National", "N" and Shield Device, and "Union Carbide" are registered trade-marks of Union Carbide Corporation

NATIONAL CARBON COMPANY • Division of Union Carbide Corporation • 30 East 42nd Street, New York 17, N. Y.

Sales Offices: Atlanta, Chicago, Dallas, Kansas City, Los Angeles, New York, Pittsburgh, San Francisco. *In Canada:* Union Carbide Canada Limited, Toronto.

Askania Regulator Company NEWS

***Automatic Controls for* COMBUSTION • PRESSURE FLOW • STRIP EDGE POSITION • STRIP THICKNESS**



NEW BULLETIN DESCRIBES HOW AUTOMATIC EDGE CONTROL CAN BE INSTALLED ON NEW *OR EXISTING* STRIP LINE

Explains how it operates Accurately on *Any Strip* at *Any Speed*

ASKANIA REGULATOR COMPANY Bulletin No. 33.1 is now off the press and available to the Metal Industry. It describes performance advantages, applications, method of installation and control, and identifies the specific models from which to select.

It explains how these controls are designed to hold the lateral position (or centerline) of strip traveling up to and over 5,000 feet per minute...to within 0.030 inch of the desired edge position.

Well Illustrated

Bulletin 33.1 contains twelve special diagrams and illustrations. These emphasize the simplicity with which Askania Edge Position Controls are applicable to *any continuous processing operation* involving moving strip.

Some continuous applications are:

Pickling Lines
Annealing Lines
Cleaning Lines
Coating Lines
Slitting Lines
Trimming Lines
Galvanizing Lines
Plating Lines

Do you have these problems?

The four basic categories of Askania Edge Position Controls are explained in detail. These are:

1. Uncoiling strip for delivery at a constant edge position
2. Recoiling strip with one straight edge
3. Guiding strip at intermediate points along continuous lines
4. Guiding center line of moving strip

Are you familiar with these variations?

Model 110—For Light Duty, Medium Speed Service
Model 200—For Heavy Duty, Slow Speed Service
Model 210—For Heavy Duty, Medium Speed Service
Model 300—For Heavy Duty, High Speed Service

Inform Yourself

It pays to be informed—and Bulletin 33.1 contains the type of information you need. You'll be interested in facts proving the importance of simplicity...non-contact operation...ease of maintenance...non-clogging—easy installation, etc. as exemplified by ASKANIA EDGE POSITION CONTROLS.

Send for YOUR copy Today

Write Askania Regulator Company, 246 E. Ontario St., Chicago 11, Ill.

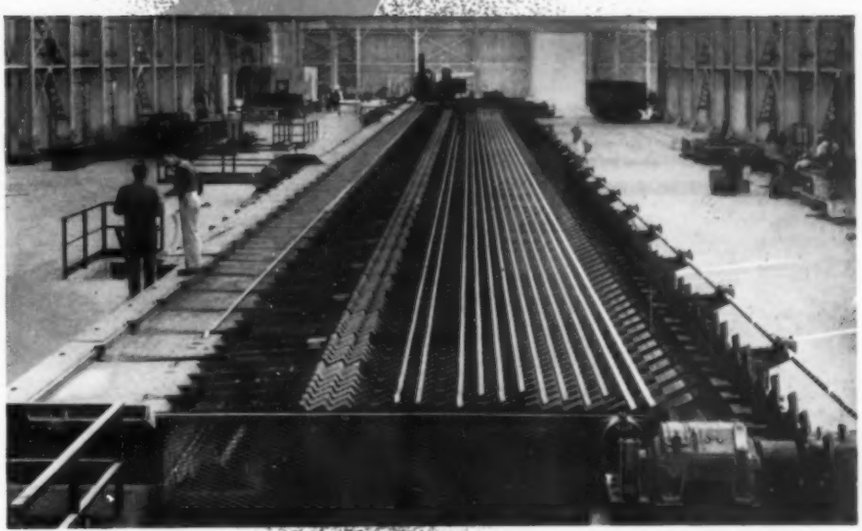
ASKANIA REGULATOR COMPANY
"CONTROLS FOR INDUSTRY"
HYDRAULIC, ELECTRONIC CONTROLS & SERVOS, GENERAL SYSTEMS, ENGINEERING & COMPUTER SERVICE, VALVE ACTUATORS & CYLINDERS
A SUBSIDIARY OF GPE

MORGAN MILLS
MORGAN QUALITY

from START to FINISH

MERCHANT AND ROD MILL
Atlantic Steel Company
Atlanta, Georgia

Morgan engineered and equipped from charging car to cooling bed this new Atlantic Steel Mill is now in full operation. This mill is just one of two hundred and twenty-one Morgan continuous rolling mills which have been purchased by steel plants throughout the world.

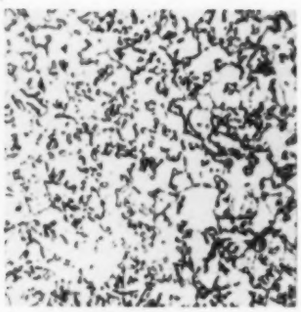


MORGAN
WORCESTER

MORGAN CONSTRUCTION CO., Worcester, Massachusetts

Rolling Mills • Morgoil Bearings • Wire Mills • Regenerative Furnace Control • Ejectors • Gas Producers

carbon-restored steel meets tightest specs



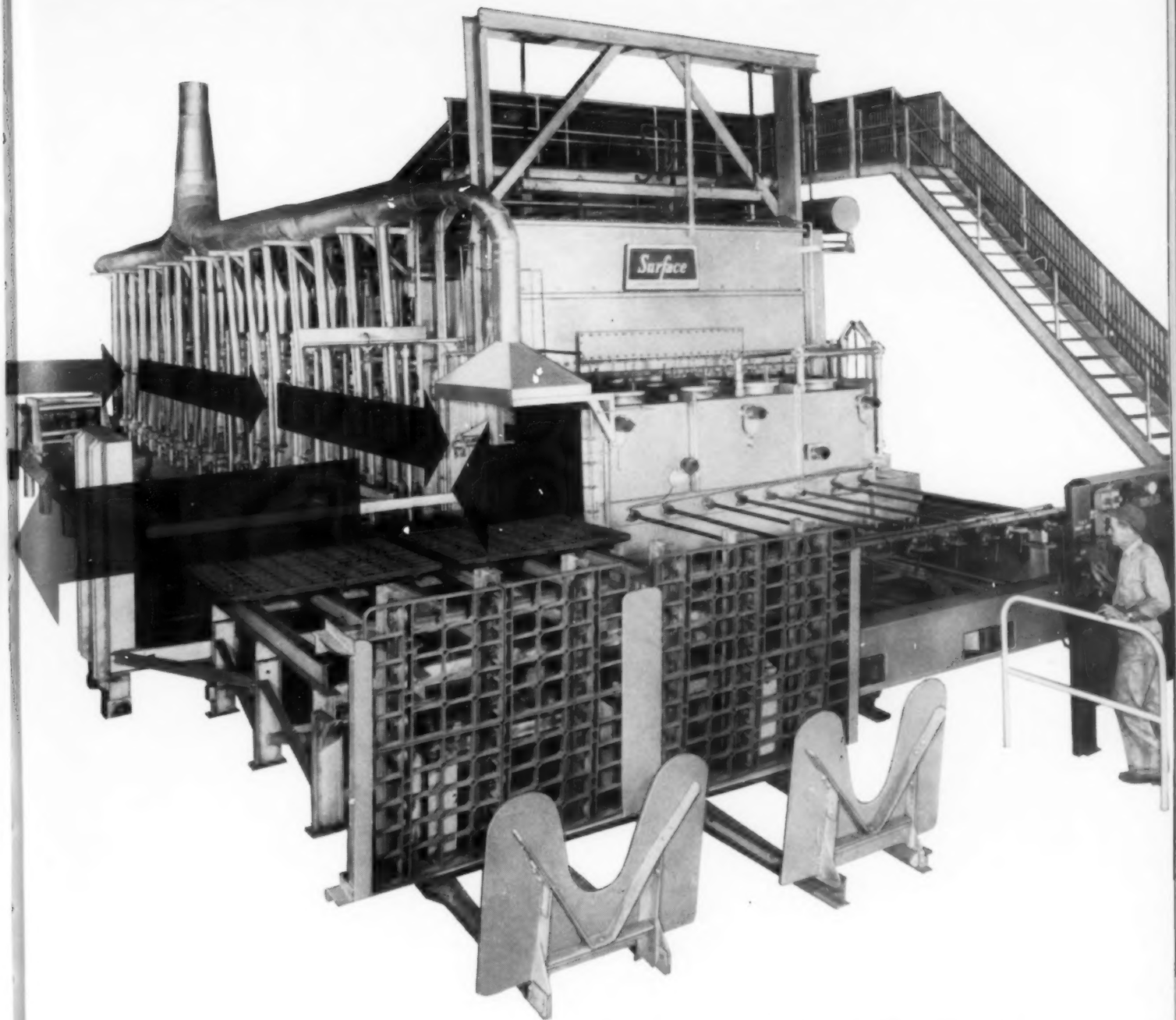
■This steel mill easily meets the steadily tightened specifications of customers who demand stock with good surface finish, no "decarb," and uniform microstructures suitable for cold forming and automatic machining.

They do it by combining annealing and carbon restoration in a Surface continuous furnace. They get all the flexibility of cycle control they need with 6 zones, individually controlled. An RX® gas generator keeps the carbon potential of the furnace atmosphere in balance with the steels being treated. Automatic dew point recorders provide a continuous check on the atmosphere.

Production rates up to 1,000 tons per month make this furnace a profitable tool.

Again, Surface engineering transforms difficult specifications into profitable opportunities.

Surface Combustion Corporation, 2404 Dorr Street, Toledo 1, Ohio. In Canada: Surface Industrial Furnaces, Ltd., Toronto, Ontario.



you can meet these specifications:

CYCLE ONE (sub-critical anneal)		CYCLE TWO (over-critical anneal)	
STEEL (AISI)	MAXIMUM-BRINELL	STEEL (AISI)	MAXIMUM-BRINELL
4042	160	4037	151
4140	170	4140	174
5140	166	8127	148
8740	170	8740	174

Cycle One production must show spheroidized structure. Cycle Two must show lamellar pearlite structure. Brinell hardness after annealing.

wherever heat is used in industry

Surface®

Roubaix, Bressoux, Liege • S. A. Forni Stein, Genoa • Chugai Ro Kogyo Kaisha, Ltd., Osaka • Benno Schilde Maschinenbau, A. G., Bad Hersfeld

How perfectly simple —this Fast's Coupling with purely mechanical flexibility!

1. A hub is keyed on each shaft. Hubs are splined at maximum distance from shaft ends.

2. Floating sleeves surround hubs. Sleeves are splined to engage hub splines.

3. Sleeves compensate for shaft misalignment by assuming neutral position between two hubs.

4. Because of distance from shaft end, any misalignment between splines is mere fraction of same misalignment between shafts.

5. Sleeves carried on bearing rings, located on *transverse center line* of hub spline faces (the load-carrying surfaces) no crank action, no vibration.

6. Lubricant is centrifugally forced into spaces between engaged splines, forming a film.

For 35 years the most positive, dependable means of coupling machines to their power source . . . Fast's Couplings have no parts subject to repeated bending, tension or compression. Because there is no metal-to-metal contact, *there is no wear*—in fact, many Fast's Couplings in use for over 30 years show no signs of wear when disassembled! No leather, plastic or rubber oil seals. Lubricant film distributes pressure over a considerable area, diminishing localized stress at pressure points on the load-carrying teeth. Perfectly simple? Yes . . . and foolproof!

For coupling catalog, technical advice or assistance from Koppers field engineers, write: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 3011 Scott Street, Baltimore 3, Maryland.

THE ORIGINAL **FAST'S Couplings**

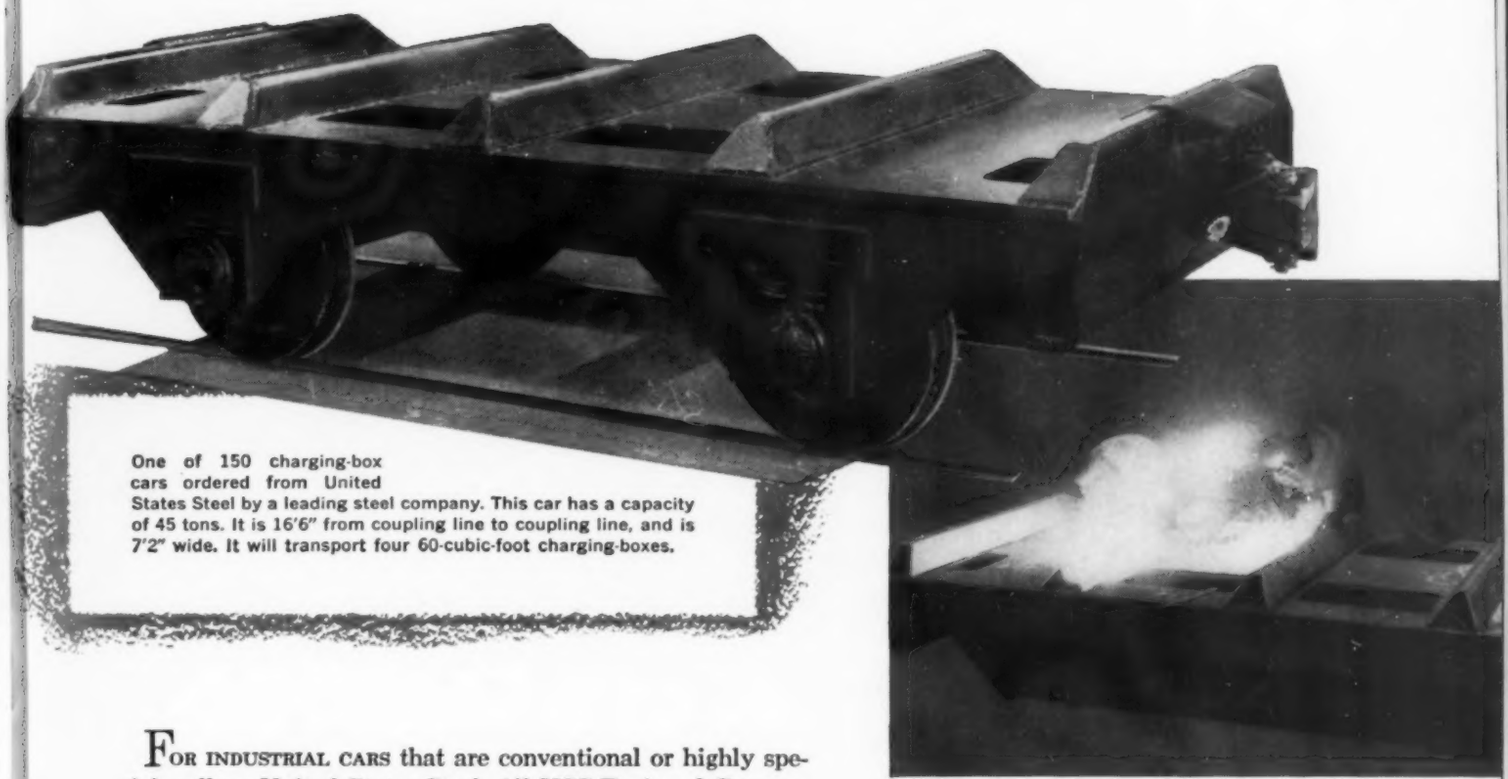
KOPPERS

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE 3, MD.
This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Industrial Gas Cleaning Apparatus, Aeromaster Fans.
***Engineered* Products Sold with *Service*.**

You can get charging-box cars

USS-DESIGNED

to your specifications



One of 150 charging-box cars ordered from United States Steel by a leading steel company. This car has a capacity of 45 tons. It is 16'6" from coupling line to coupling line, and is 7'2" wide. It will transport four 60-cubic-foot charging-boxes.

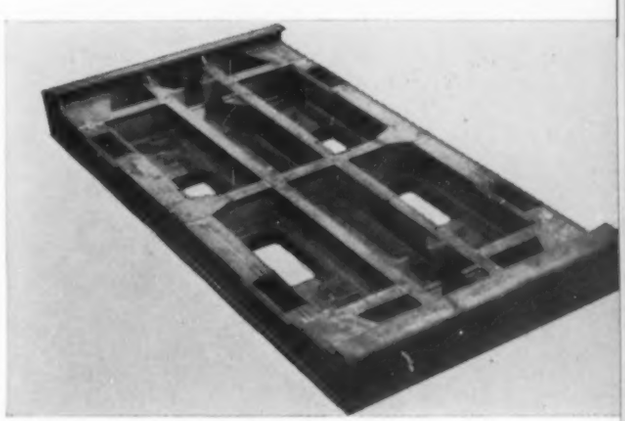
Separators for charging-boxes being welded to car. Separators are fabricated from welded steel plate.

FOR INDUSTRIAL CARS that are conventional or highly special, call on United States Steel. All USS-Designed Cars are custom-made to meet your exact specifications.

A good example is the charging-box car shown here—one of 150 cars being built to the general specifications of our customer. This all-welded steel car has a capacity of 45 tons, and will transport four 60-cubic-foot charging-boxes.

Car has eight "cutouts" in its inch-and-a-half steel upper deck plate to make it lighter. Its four wheels are equipped with outboard bearings, and it is for use on standard-gage track.

Capacity, running gear, and other design features of charging-box cars can be varied to suit your needs. Our engineers will be pleased to call at your convenience to discuss your requirements for this or any kind of industrial cars. For more information, meanwhile, send for a free copy of our 32-page illustrated booklet—"USS Custom Designed Cars."



Note rugged underframe of car.

USS INDUSTRIAL CARS

USS

UNITED STATES STEEL CORPORATION, PITTSBURGH
COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA.
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

United States Steel Corporation
525 William Penn Place, Room 2718
Pittsburgh 30, Pennsylvania

Please send me a free copy of your 32-page booklet, "USS Custom Designed Cars."

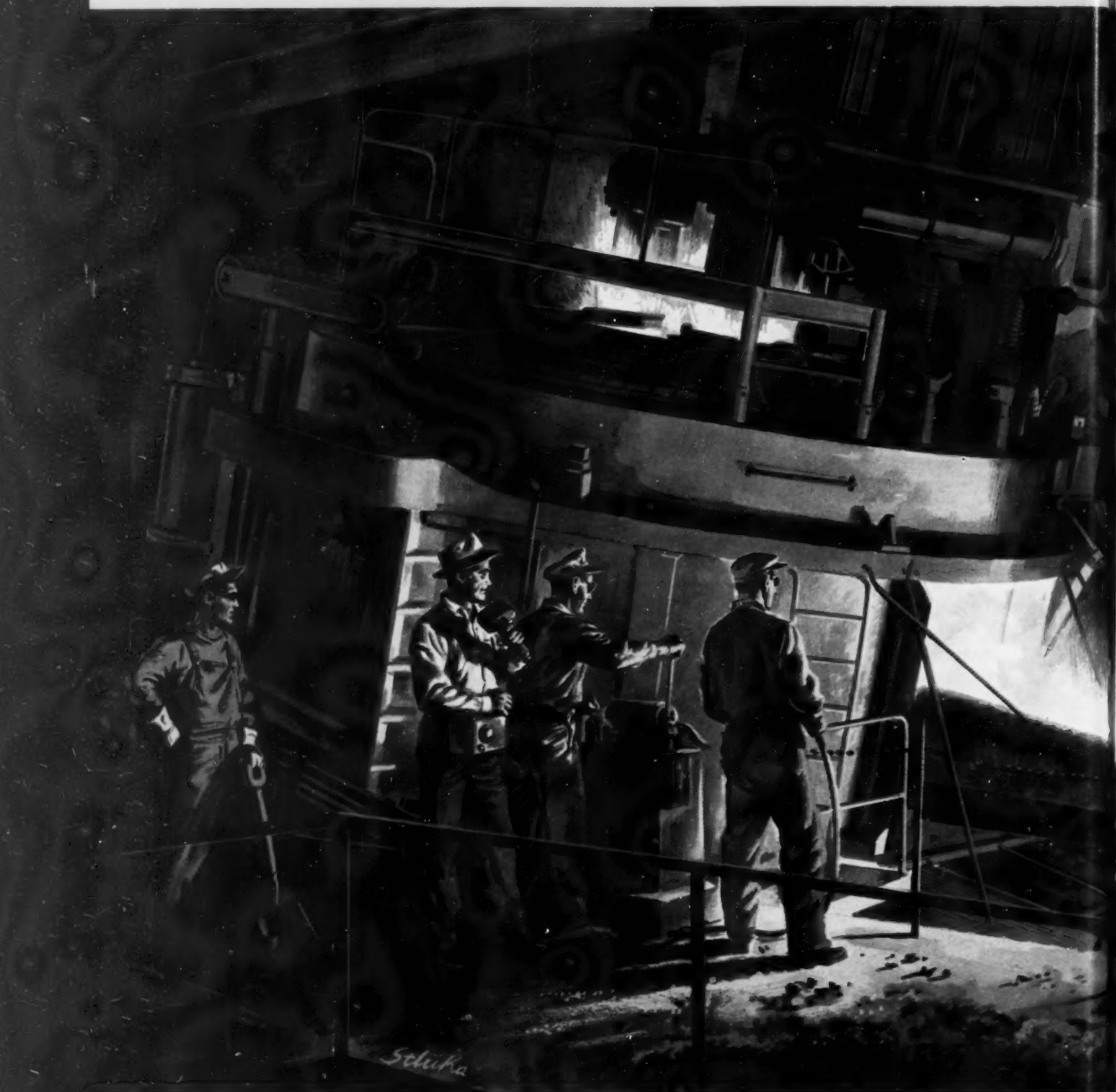
Name .....

Company .....

Address .....

City ..... State .....

ALLIS-CHALMERS . .



Products for steel: motors, m-g sets, control, pumps, *Texrope* drive equipment, crushers, mills, screens, rectifiers, transformers, substations, switchgear, circuit breakers, turbine-generators, voltage regulators, blowers, compressors, synchronous condensers, and water conditioning equipment.

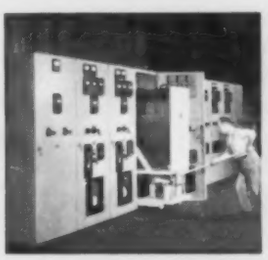
ALLIS-

. . in Step with STEEL

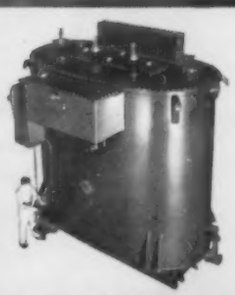
The arc furnace

Reduced costs result when Allis-Chalmers control, transformers and switchgear are specified for arc furnace application. The reason: A-C offers these products as a specially-integrated electrical system — designed by experts in furnace requirements and backed by Allis-Chalmers 75 years of experience in supplying equipment to the steel industry.

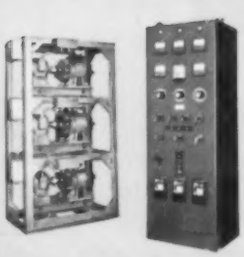
Wherever steel goes — from mine to final processing — Allis-Chalmers equipment is available to keep quality high, keep steel moving fast and profitably. Contact the A-C representative in your district, or write to Allis-Chalmers, Milwaukee 1, Wisconsin.



Arc furnace switchgear provides safe, dependable protection for transformer and related equipment. Special alloys assure long arcing contact life under severe interrupting duty, keeping maintenance and downtime to a minimum.



Transformers are of well-balanced designs and built for heavy duty . . . performance has been proven in 25-30 years of repeated daily short-circuits in electrical furnace operation.



. . . and Control requirements are met by Magnetic Amplifier and *Regulex* controls which balance arc current with arc voltage to maintain desired arc condition automatically. These controls result in high tonnage per kwhr, long life for electrodes and furnace linings, and a minimum of maintenance.

CHALMERS

A-C ALLIS-CHALMERS

Regulex and *Texrope* are Allis-Chalmers trademarks.

A-5363

How HYATT bearing advantages help produce more steel at lower cost:

ON TABLE ROLLS—SEPARABLE HYATTS GREATLY FACILITATE ROLL REPLACEMENT!

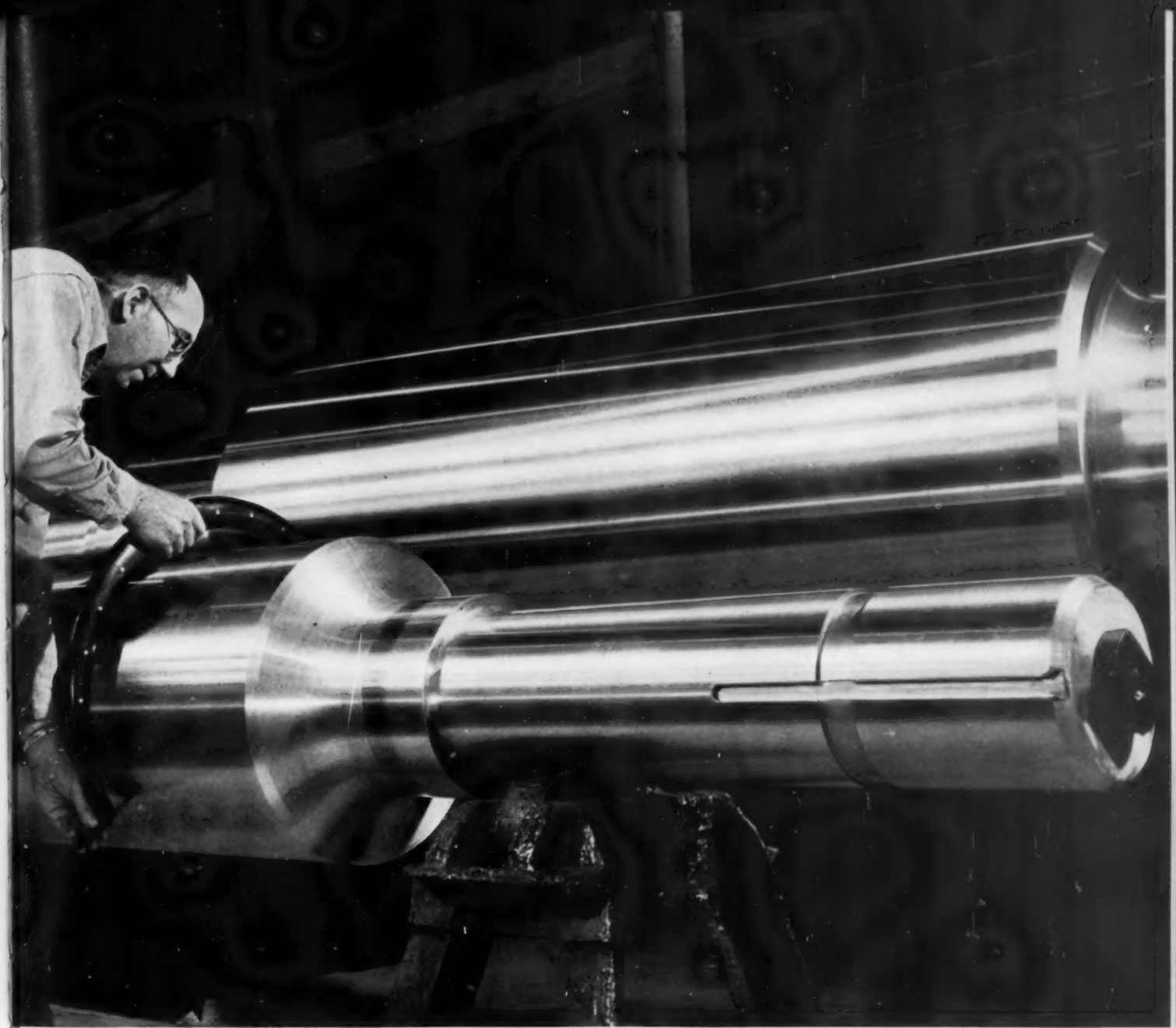
When table rolls must be removed for repair, separable-race HYATT Hy-Rolls cut costly downtime to the minimum because they can be disassembled and reassembled so rapidly. Their straight cylindrical design not only provides maximum load-carrying capacity and resistance to shock loads, but permits roll expansion under high heat. Service-proved advantages like these have made HYATT Hy-Rolls first choice of the steel industry for decades—and constantly-improved quality makes HYATTS more than ever your best buy today! Hyatt Bearings Division, General Motors Corporation, Harrison, N.J.; Pittsburgh; Detroit; Chicago; Oakland, Calif.

STANDARDIZE ON HYATTS FOR:
MAIN TABLES • RUNOUT TABLES • FURNACE TABLES
FEED ROLLERS • AUXILIARY ROLLERS • LINESHAFTING
MILL MOTORS • CRANES • CHARGING AND INGOT CARS

THE RECOGNIZED LEADER IN CYLINDRICAL BEARINGS

GM GENERAL MOTORS

HYATT HY-ROLL BEARINGS FOR STEEL INDUSTRY



Two More Big Ones Ready to Go

Here are two Bethlehem forged-steel rolls that were photographed in the shop as they were being readied for shipment. The unit shown in the background is a real heavyweight, just about as massive as they come. The one being calipered isn't exactly a midget itself.

Because of their overall dimensions, big rolls like these are the "show pieces" of the shops. But of course, they by no means represent the entire Bethlehem line. No matter what size—or what type—you require, Bethlehem will make it for you. Some of the rolls we produce weigh 20 tons or more. Others are so small that they can be lifted by hand.

All Bethlehem rolls, regardless of size, are made with exacting care. When you entrust us with your order, you can be sure that specifications on hardness, finish, and other details will be met in full. And the job will be finished on time.

We suggest you call us the next time you're in the market. Remember, forged-steel rolls have been a Bethlehem specialty for many years.

TYPICAL USES FOR BETHLEHEM FORGED-STEEL ROLLS

Cold-rolling ferrous sheets and strip

Running-down and finishing operations on copper and brass sheets

Hot- and cold-rolling aluminum sheets

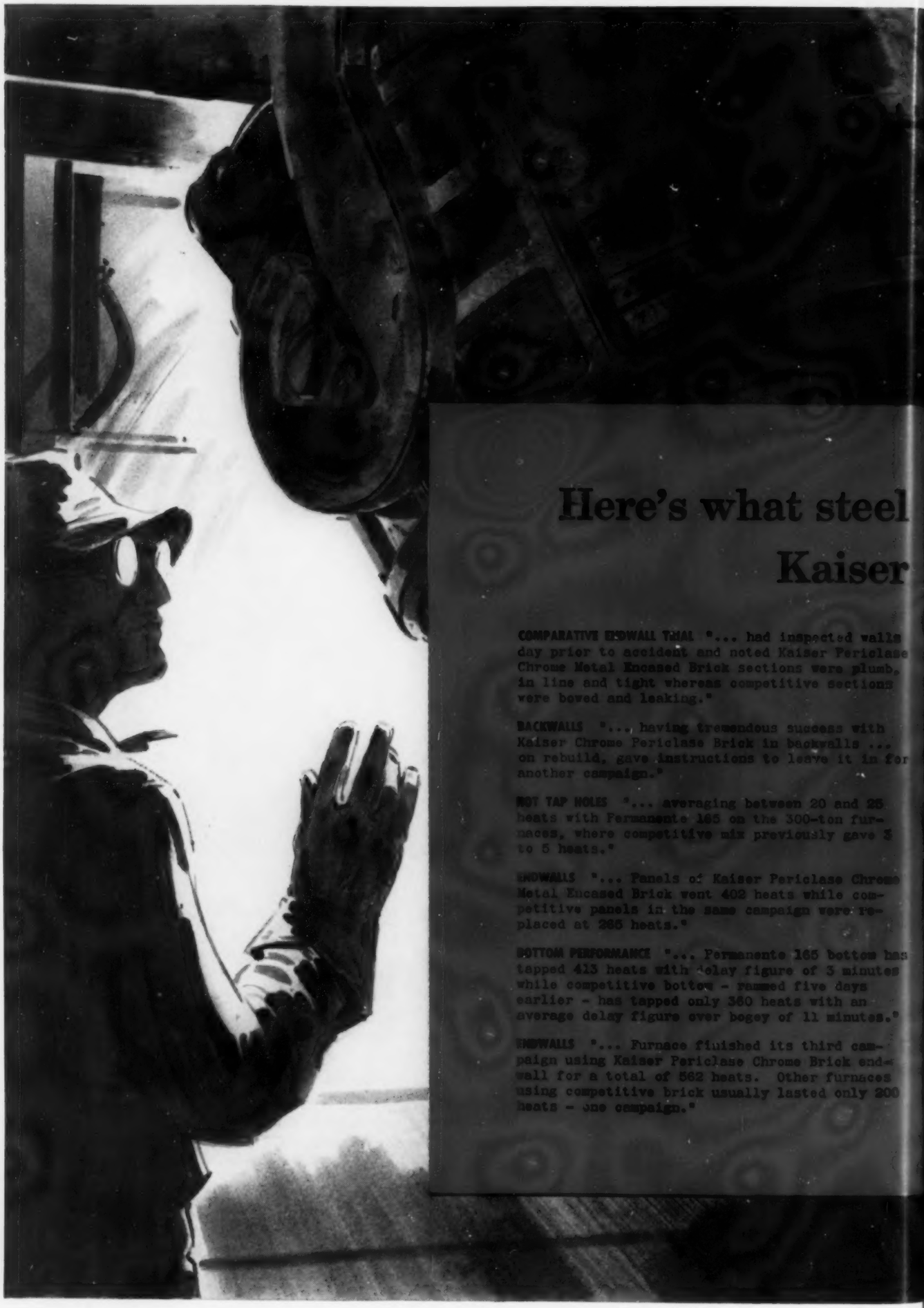
Cold-rolling aluminum foil

BETHLEHEM STEEL COMPANY, BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL

BETHLEHEM STEEL



Here's what steel Kaiser

COMPARATIVE ENDWALL TRIAL "... had inspected walls day prior to accident and noted Kaiser Periclase Chrome Metal Encased Brick sections were plumb, in line and tight whereas competitive sections were bowed and leaking."

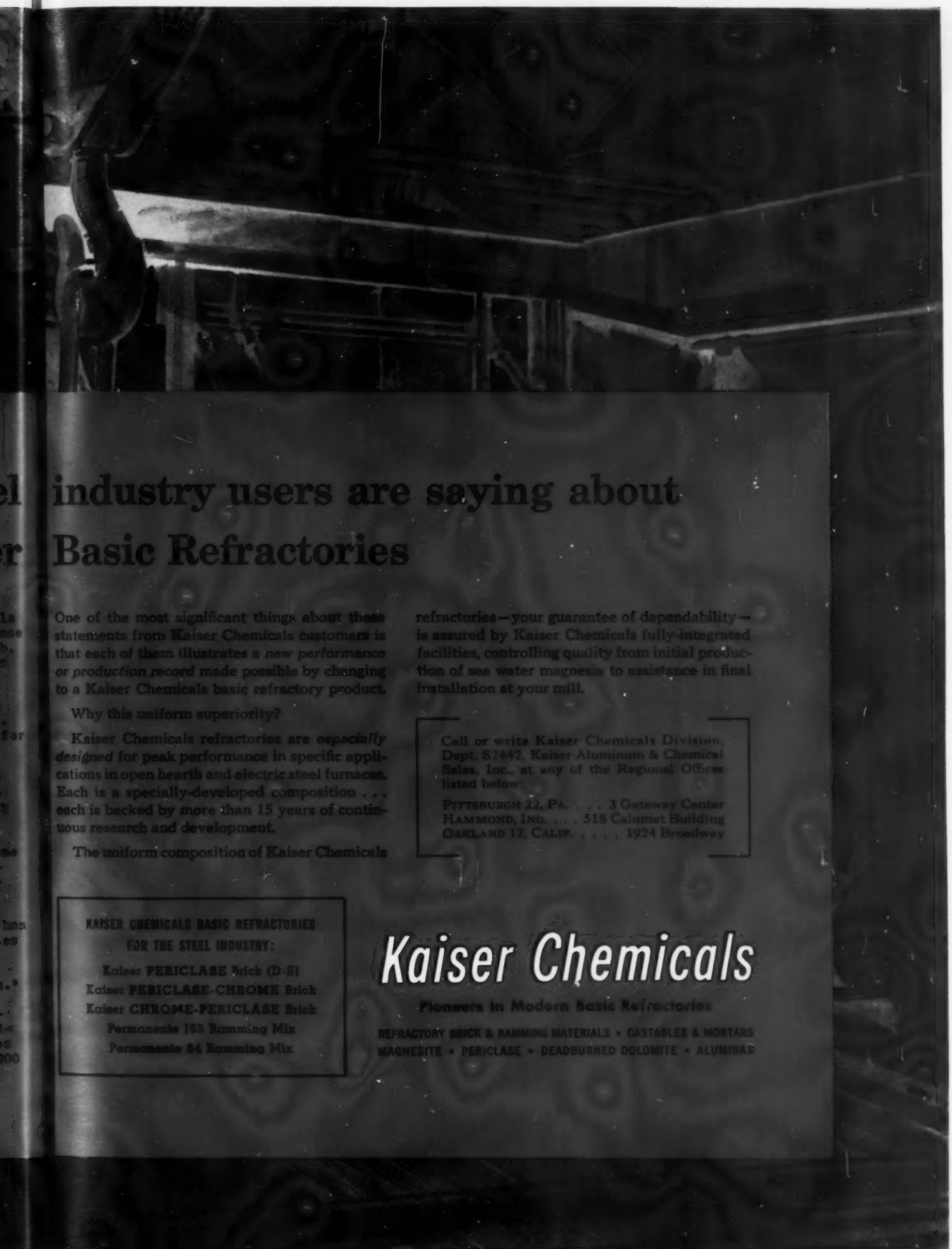
BACKWALLS "... having tremendous success with Kaiser Chrome Periclase Brick in backwalls ... on rebuild, gave instructions to leave it in for another campaign."

HOT TAP HOLES "... averaging between 20 and 25 heats with Permanente 165 on the 300-ton furnaces, where competitive mix previously gave 3 to 5 heats."

ENDWALLS "... Panels of Kaiser Periclase Chrome Metal Encased Brick went 402 heats while competitive panels in the same campaign were replaced at 265 heats."

BOTTOM PERFORMANCE "... Permanente 165 bottom has tapped 413 heats with delay figure of 3 minutes while competitive bottom - rammed five days earlier - has tapped only 360 heats with an average delay figure over bogey of 11 minutes."

ENDWALLS "... Furnace finished its third campaign using Kaiser Periclase Chrome Brick endwall for a total of 562 heats. Other furnaces using competitive brick usually lasted only 200 heats - one campaign."



industry users are saying about Basic Refractories

One of the most significant things about these statements from Kaiser Chemicals customers is that each of them illustrates a *new performance or production record* made possible by changing to a Kaiser Chemicals basic refractory product.

Why this uniform superiority?

Kaiser Chemicals refractories are *especially designed* for peak performance in specific applications in open hearth and electric steel furnaces. Each is a specially-developed composition . . . each is backed by more than 15 years of continuous research and development.

The uniform composition of Kaiser Chemicals refractories—your guarantee of dependability—is assured by Kaiser Chemicals fully-integrated facilities, controlling quality from initial production of sea water magnesia to assistance in final installation at your mill.

Call or write Kaiser Chemicals Division, Dept. S7442, Kaiser Aluminum & Chemical Sales, Inc., at any of the Regional Offices listed below:

PITTSBURGH 22, PA. . . . . 3 Gateway Center
HAMMOND, IND. . . . . 518 Calumet Building
OAKLAND 12, CALIF. . . . . 1924 Broadway

KAISER CHEMICALS BASIC REFRACTORIES FOR THE STEEL INDUSTRY:

Kaiser PERICLASE Brick (D-S)
Kaiser PERICLASE-CHROME Brick
Kaiser CHROME-PERICLASE Brick
Permanente 165 Ramming Mix
Permanente 84 Ramming Mix

Kaiser Chemicals

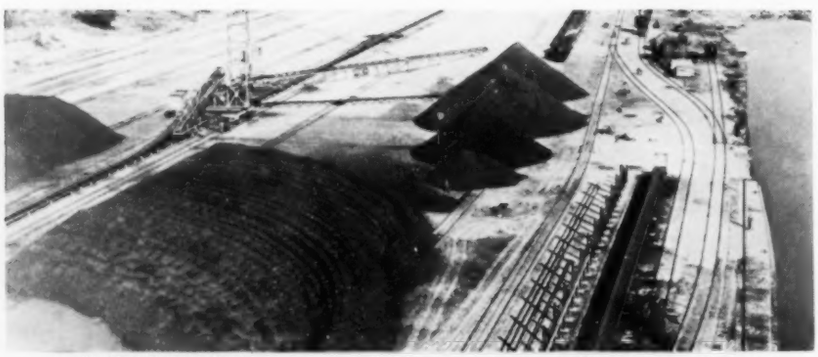
Pioneers in Modern Basic Refractories

REFRACTORY BRICK & RAMMING MATERIALS • CASTABLES & MORTARS
MAGNESITE • PERICLASE • DEADBURNED DOLOMITE • ALUMINAS

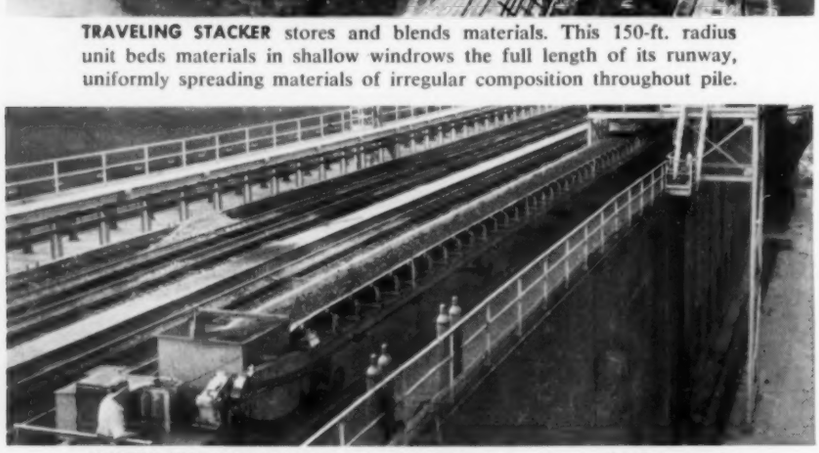
6000-TPH BELT CONVEYOR provides continuous handling of raw materials from ships to storage or screen house—performs a job deemed impossible with conventional transportation. Materials discharge from apron feeder to this 60-in. wide, 1260-ft. long conveyor on first leg of mile-long journey. System works year-round—in all weather.

How LINK-BELT developments in materials handling

stay in step



TRAVELING STACKER stores and blends materials. This 150-ft. radius unit beds materials in shallow windrows the full length of its runway, uniformly spreading materials of irregular composition throughout pile.



SHUTTLE BELT CONVEYOR, fed by "high line" conveyor, distributes coke into blast furnace stock bins. This highly flexible conveyor is reversible —provides low-cost materials distribution.

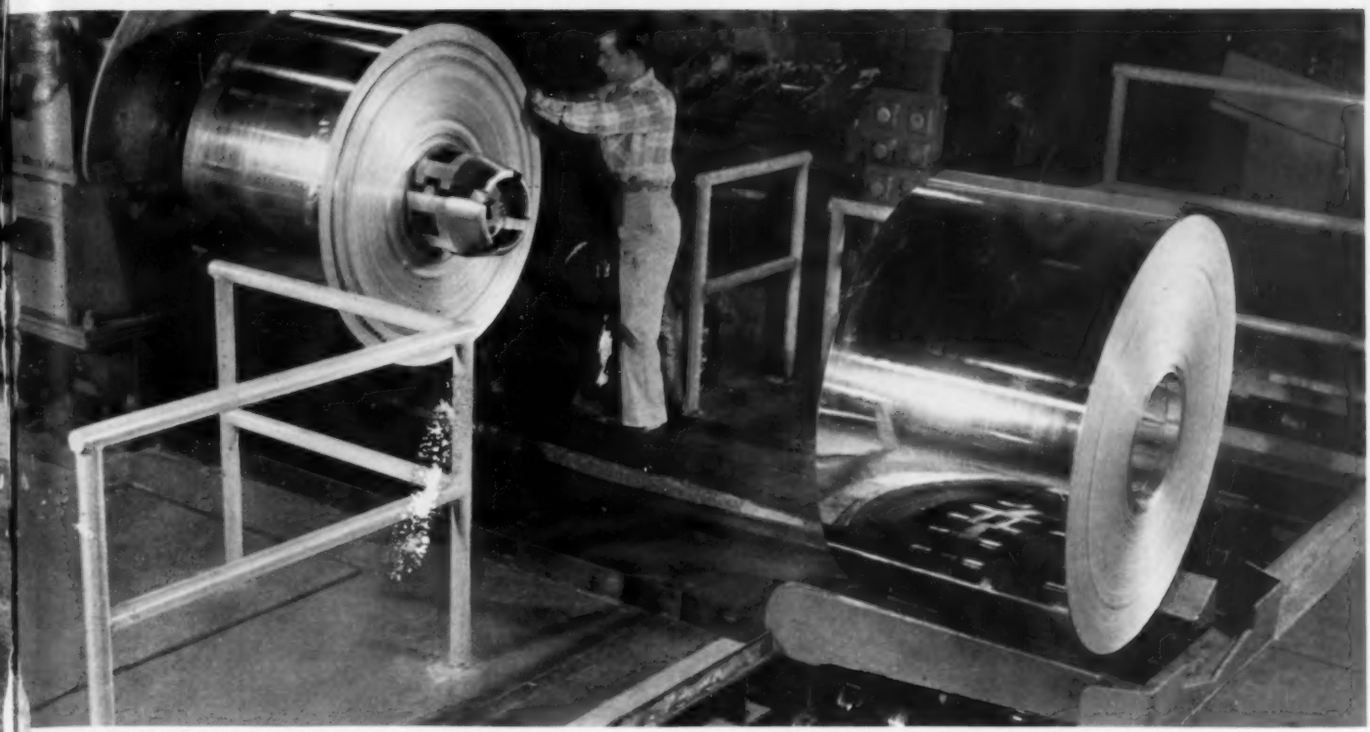
For basic raw materials—bulk handling equipment to keep pace with modern burdening techniques

TODAY'S blast furnace burdening techniques require higher tonnages of raw materials, more extensive storage areas and separate stockpiles for a greater number of ores. In furnishing complete, high-capacity handling systems for both new and expanding mills, Link-Belt helps avoid and relieve problems of storing and reclaiming ores, coke, stone, pellets and sinter.

Regardless of the size or physical layout of your mill, Link-Belt can help you coordinate material flow to fit into new processes . . . meet higher capacities of ship unloading . . . increase production. For facts, call your nearest Link-Belt office. 14,554

LINK-BELT

MATERIALS HANDLING, PROCESSING & POWER TRANSMISSION MACHINERY



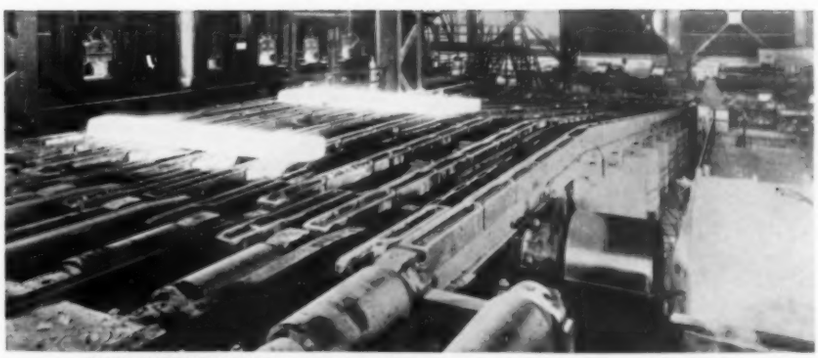
LINK-BELT CHAIN CONVEYORS effortlessly move coils weighing up to 75,000 lbs. Since product handling represents a large proportion of steel production costs, Link-Belt is continually developing equipment to increase output, lower costs and improve safety. Link-Belt offers a full range of conveyors designed to handle all steel products.

with steel demand

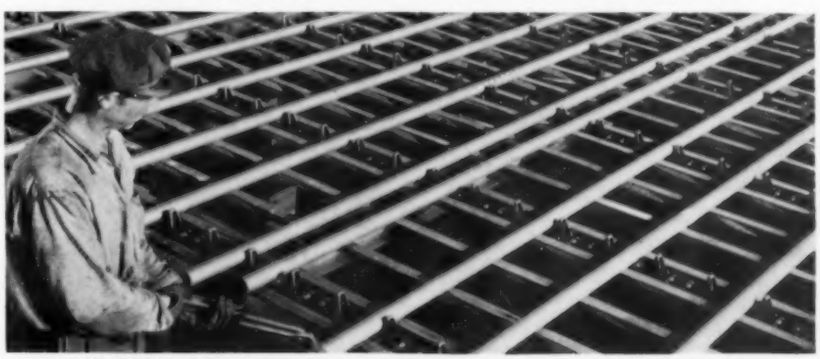
For steel in every form—conveyors to cut handling costs, improve safety, make better use of space

FROM white-hot billets to finished steel products, Link-Belt conveyors help modern mills boost yield, cut waste. Large tonnages are handled dependably, yet gently enough to reduce damage and scrap losses. By limiting crane movements and eliminating travel of vehicles in the vicinity of crews, safety is improved. Other Link-Belt equipment provides effective means for cooling hot products . . . provides active storage . . . permits existing processing equipment to be used to its maximum capacity.

Whether you're planning a new plant or modernizing, get in touch with your nearest Link-Belt office.

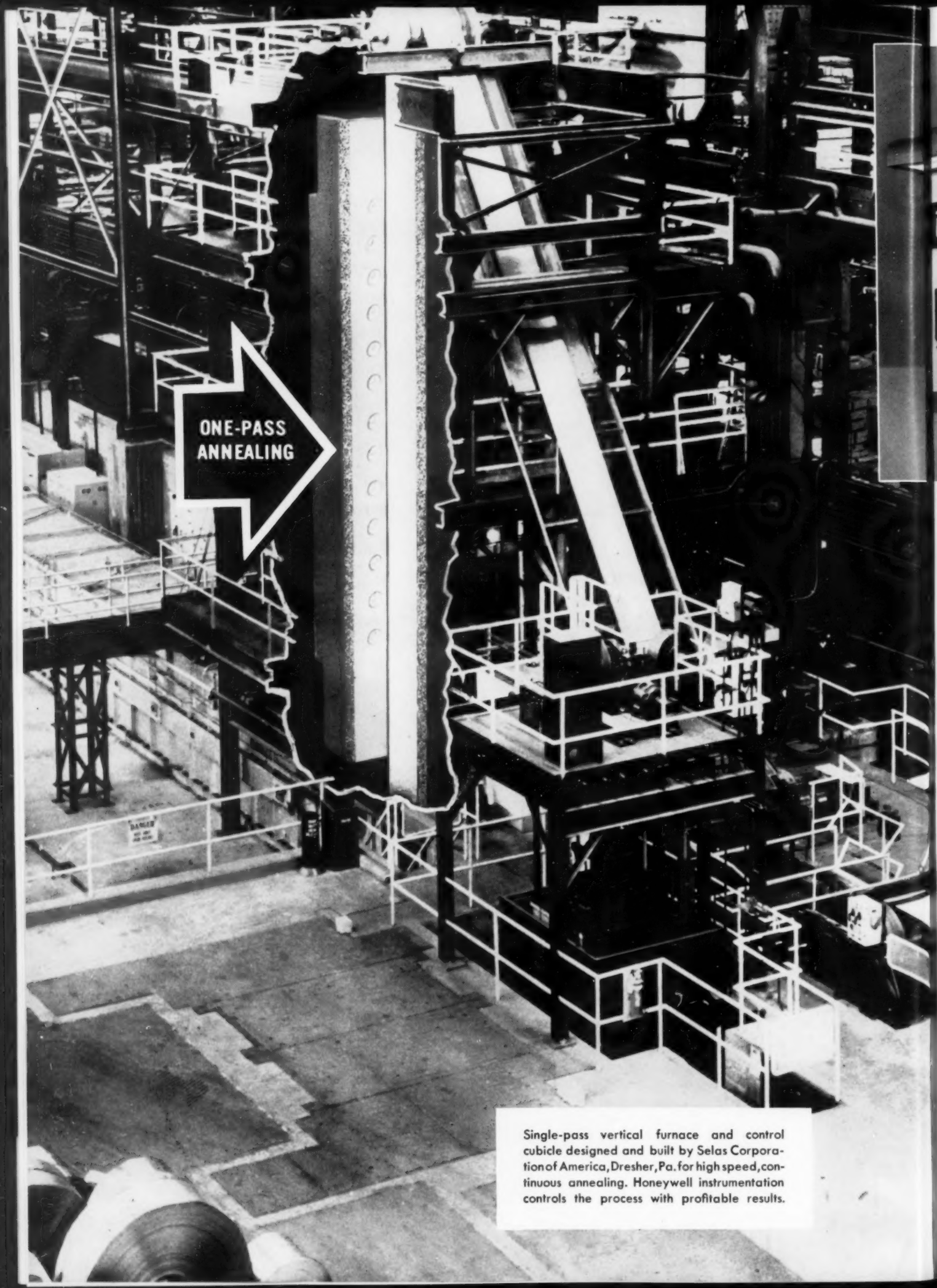


DUAL-PURPOSE CHAIN CONVEYOR cools as it transfers heavy, white-hot billets between shear-line and furnace tables. Link-Belt chains withstand continuous heavy loads and severe shock, resist abrasion and corrosion.

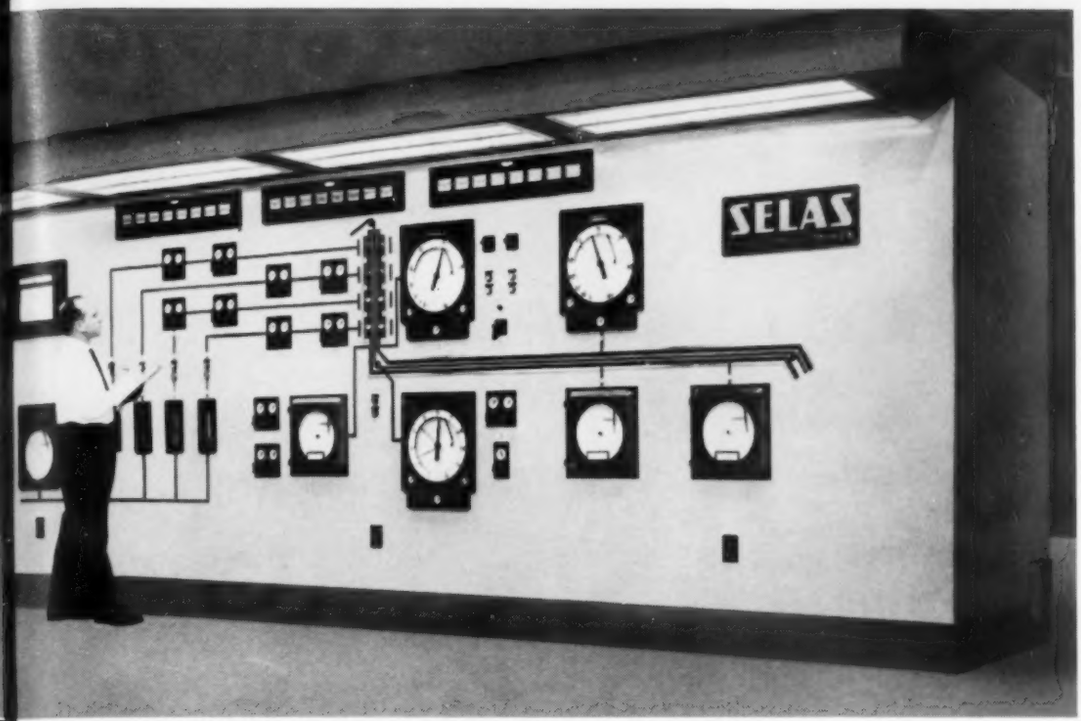


LINK-BELT PROMAL CHAIN with pusher attachments provides controlled cooling of longer pipe than previously possible. Conveyor receives tubes directly from furnace—controlled speed permits uniform cooling.

LINK-BELT COMPANY: Executive Offices, Prudential Plaza, Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville (Sydney), N.S.W.; South Africa, Springs. Representatives Throughout the World.



Single-pass vertical furnace and control cubicle designed and built by Selas Corporation of America, Dresher, Pa. for high speed, continuous annealing. Honeywell instrumentation controls the process with profitable results.



Honeywell ***ElectroniK*** Recording Controllers measure sheet temperatures, and line speed, in combination with Honeywell Flow Meter, which records and integrates fuel consumption.

Process Temperature Control

pays off in quality and production in Selas strip annealing line

with Honeywell instrumentation

Steel strip is fully annealed in one pass through a Selas vertical furnace, and delivered continually to the galvanizing bath. In this operation, radiant gas heat is accurately applied across the strip width at temperatures best suited to production of highest quality galvanized steel.

Honeywell instruments, mounted on the graphic panel of a Selas cubicle, provide the fine degree of temperature control required by the process. These instruments control heat input by integrating *strip speed*, *fuel input* and *strip temperature measurements*. Precise heat control speeds the heating process and assures reproducible uniformity, regardless of variations in gauge.

Honeywell instrumentation brings equally profitable results in many steelmaking applications. Your nearby Honeywell field engineer can help you gain its advantages in your own plant. Call him today . . . he's as near as your phone.

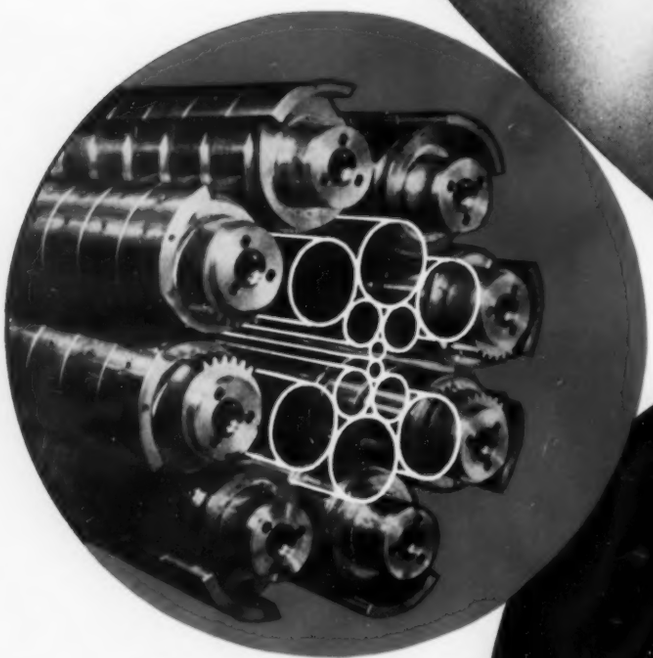
MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

Honeywell

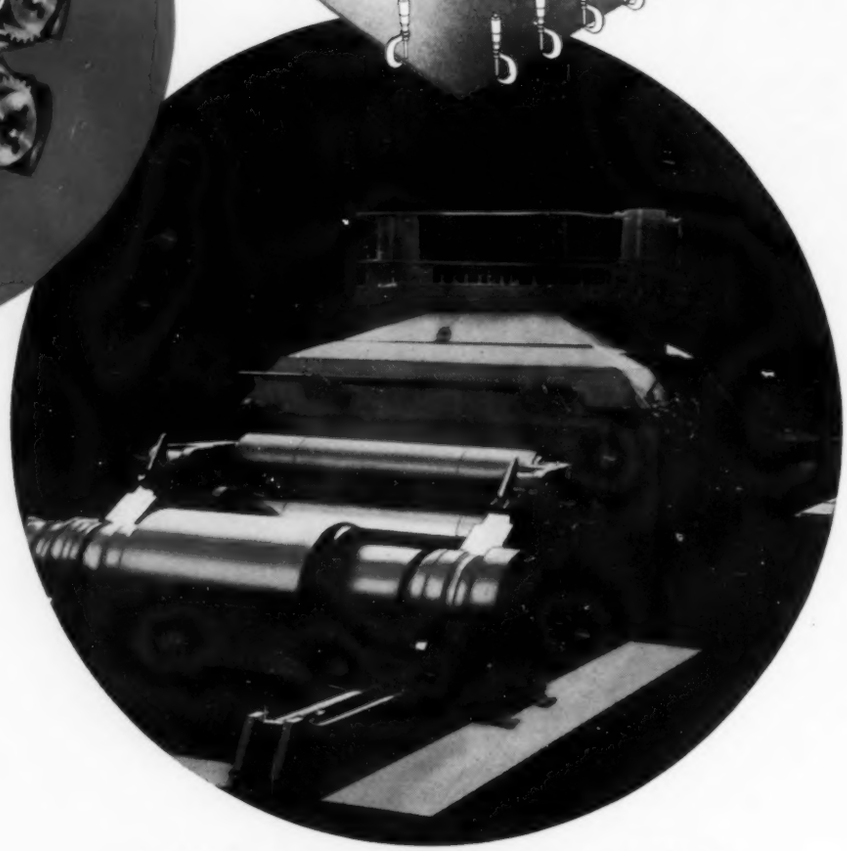
H HONEYWELL *First in Controls*

This 80" SENDZIMIR MILL

maintains precise gauge across the width and along length of strip



Phantom view of roll arrangement



This Sendzimir cold strip mill rolls 80" wide low carbon steel from hot rolled thickness to .024" with total gauge variation of .0004". Similar uniformity is being regularly obtained on Sendzimir cold strip mills rolling brass, copper, aluminum, stainless steel, silicon steel, etc.

CONSIDER THE ADVANTAGES OF THE SENDZIMIR COLD MILL

- Extreme Accuracy In Gauge, Due To Uniform Support Throughout Mill
- Elimination Of Intermediate Anneals
- Greater Reductions Per Pass
- Highest Surface Finish
- Quick And Simple Roll Changes
- Low Initial And Maintenance Costs

SENDZIMIR MILLS

ARE ENGINEERED AND BUILT BY

THE WATERBURY FARREL FOUNDRY & MACHINE CO.

Waterbury, Conn.—U. S. A.

SALES OFFICES: Chicago • Cleveland • Millburn, N. J.

FOREIGN: SENDZIMIR Ltd., 75 Grosvenor St., London WI, England

PROCÉDÉS SENDZIMIR S.A.R.L. 73 Blvd. Malesherbes, Paris 8, France

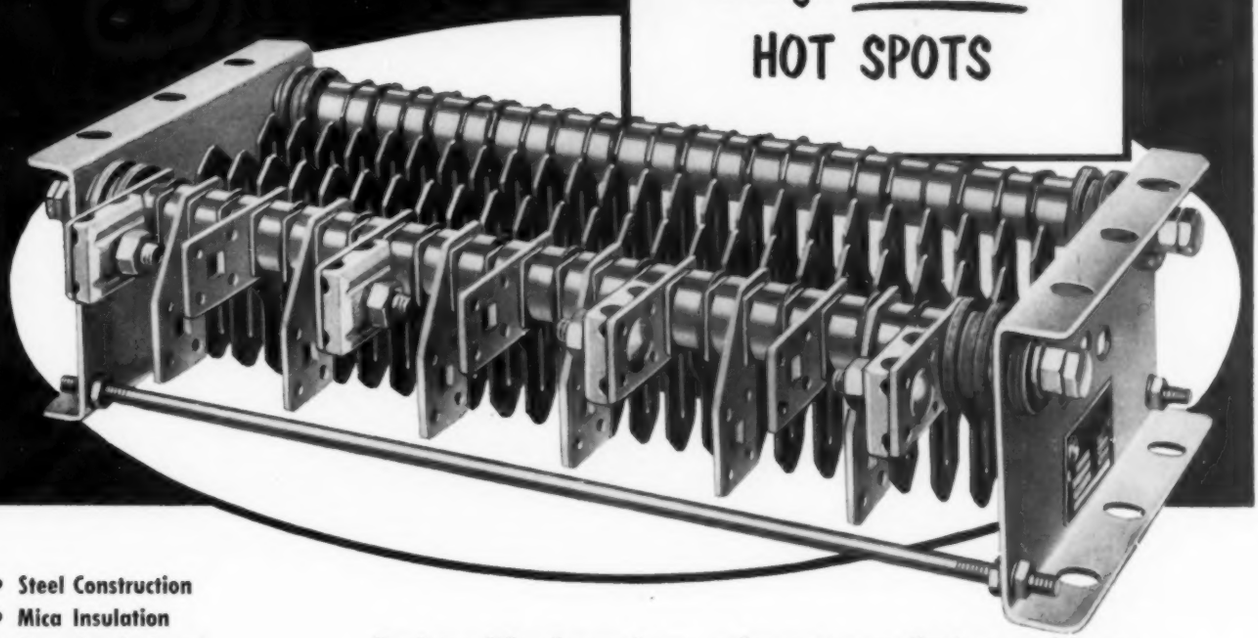
Backing Roll Support

Sendzimir Support

WF-38

Resistor life depends on adequate ventilation.....

Patented P-G Grid Design eliminates HOT SPOTS



- Steel Construction
- Mica Insulation
- Corrosion Resistant
- Vibration Proof
- Moisture Resistant
- Provision for Expansion
- Adequate Ventilation
- Rugged Terminals

Write for Bulletin No. 500

Resistor life depends on adequate ventilation and how efficiently heat may be dissipated . . . P-G grid design equalizes the amount of air space surrounding each leg or loop to obtain even heat throughout the grid area. (Note illustration.) . . . Since heat is rapidly and evenly dissipated, hot spots fail to develop and longer resistor life is assured . . . For a nonbreakable resistor (only steel and mica used) specify P-G on your next application.

The Nonbreakable Steel Grid Resistor

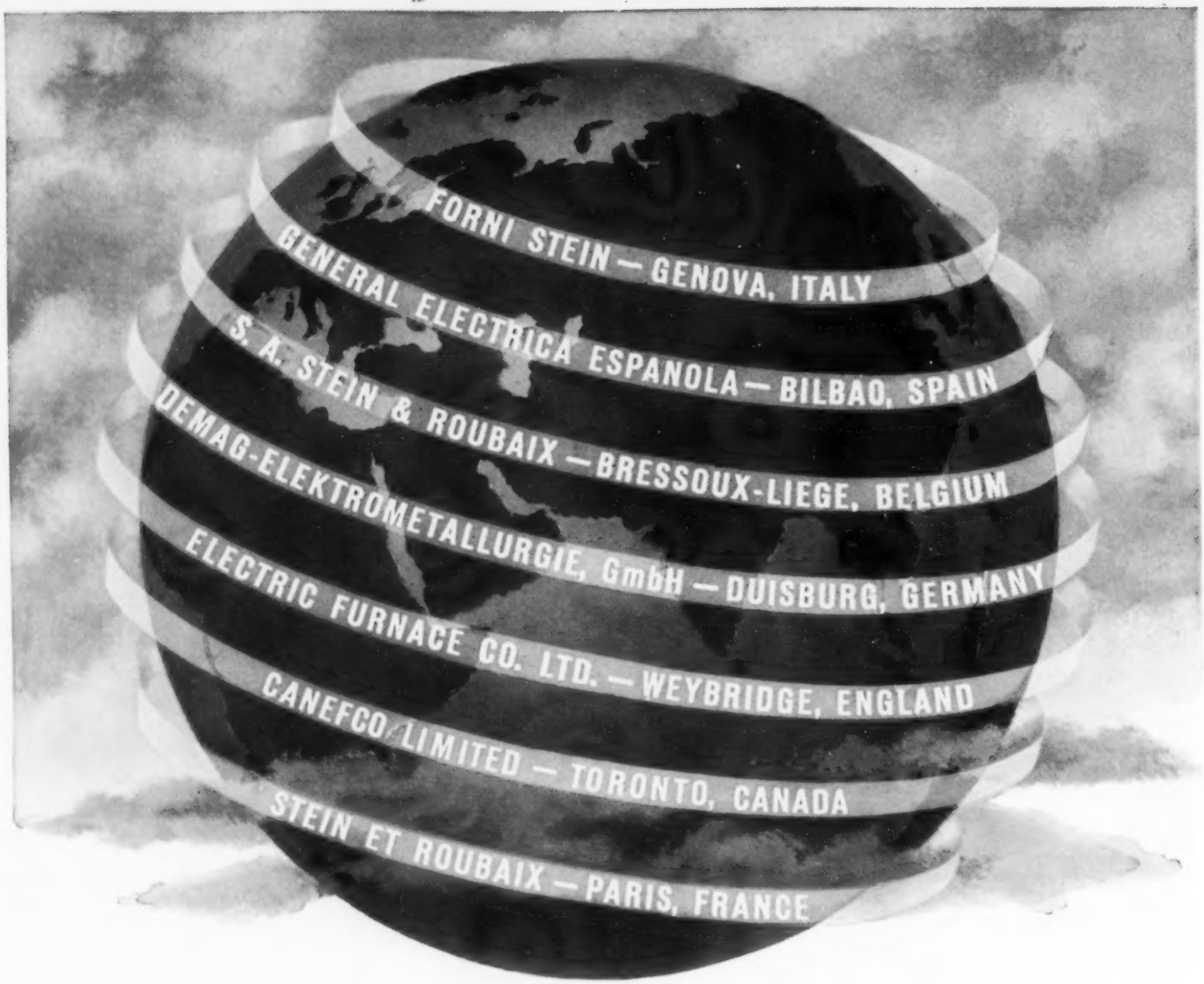
P-G

ESTABLISHED 1892

THE **POST-GLOVER** ELECTRIC COMPANY

OFFICE and FACTORY—Kenton Lands Road, Erlanger, Kentucky

MAILING ADDRESS—Box 709, Covington, Kentucky


FORNI STEIN — GENOVA, ITALY
GENERAL ELECTRICA ESPANOLA — BILBAO, SPAIN
S. A. STEIN & ROUBAIX — BRESSOUX-LIEGE, BELGIUM
DEMAG-ELEKTROMETALLURGIE, GmbH — DUISBURG, GERMANY
ELECTRIC FURNACE CO. LTD. — WEYBRIDGE, ENGLAND
CANEFCO LIMITED — TORONTO, CANADA
STEIN ET ROUBAIX — PARIS, FRANCE

'round the world they go . . .

Lectromelt* FURNACES

and a world-wide family building them

Metallurgical and chemical industries the world over use Lectromelt . . . the efficient, versatile electric furnaces designed by Lectromelt of Pittsburgh, U.S.A.

A carefully selected family of companies all over the world are licensed to manufacture and erect Lectromelt furnaces. Together, we have installations from South Africa to Finland, Chili to Canada, Turkey to Hawaii . . . anywhere melting, smelting, refining and reduction furnaces are needed.

For further information, write to Lectromelt Furnace Division, McGraw-Edison Company, 310 32nd Street, Pittsburgh 30, Pennsylvania.

**Reg. T. M. U. S. Pat. Off.*

Industry's Water Problems and Their solution

. . . . few steel plants squeeze as much use out of their water as Kaiser Steel . . . . a limited supply and stringent pollution requirements require extensive water handling and treatment . . . . water per ton of steel is as low as 1400 to 1600 gallons . . . .

By H. I. RIEGEL
Superintendent, Utilities Dept.
Kaiser Steel Corp.
Fontana, Calif.

▲ INDUSTRY'S water problems are increasing in number and scope. To solve them will require a basic understanding of the problem; an equitable solution and finally, a will to execute these solutions. There is greater individual use of water with increased population, and greater use with the increased industry and agriculture required to supply the ever-expanding needs of these people. The need for conservation of the valuable water resources is becoming more apparent and urgent throughout the entire nation.

Everytime water is used either by industry or people it deteriorates some, so that the next person or industry using it receives poorer quality until finally the water reaches the sea. In some cases the quality becomes so poor it cannot be used economically or satisfactorily. This condition prevails whether the water is discharged into a stream, or on the ground where it will percolate into underground basins from whence it is pumped for further use.

Because of the greater use of water and the greater deterioration, it has become necessary to put legislation on the books in an attempt to control man's use of these waters in such a manner that the discharge water will not affect his downstream neighbor too greatly. To dwell on the various laws and the method of administration is beyond the scope of this paper. However, in that this AISE conference is being held on the west coast and the California water laws differ from most others, and, in that the examples to be given later are located in one section of California, it is probably in order to state the general concept and the organization set up by the California laws.

The Governor of California appoints nine members of the State Water Pollution Control Board. These nine members, plus the Director of Public Health, the State Engineer, the Director of Natural Resources, and the Director of Agriculture, constitute the entire board. The nine appointed members are selected from qualified persons engaged in each of the following fields: (a) production and supply of domestic water, (b) irrigated agriculture, (c) industrial water use, (d) production of industrial waste, (e) public sewage disposal, (f) city government, and (g) County government.

The duties of the State Water Pollution Control Board are indicated by quoting portions of the pollution control legislation as follows:

(13020) (f) The State Board allocates to the regional boards from funds appropriated to the State Board such part thereof as may be necessary for the administrative expenses of such boards.

(g) It has the power to require any state or local agency to inspect and report on any technical factors involved in water pollution.

(13022) The State Board shall formulate a state-wide policy for control of water pollution with due regard for the authority of the regional boards.

(13023) The State Board shall administer any state-wide program of financial assistance for water pollution control which may be delegated to it by law and may accept funds from the United States or any person to that end.

(13024) The State Board shall administer any state-wide program of research in the technical phases of water pollution control which may be delegated to it by law and may accept funds from the United States or any person to that end. The State Board may conduct such a program independently, or by contract, or in co-operation with any federal or state agency, including any political subdivision of the State, or any person or public or private organization.

(13025) PP 1. Whenever a regional board fails to take or obtain appropriate action to correct any particular existing or threatened condition of pollution, the State Board shall direct that action to correct the condition be taken by any state agency having jurisdiction or may, itself, take such action.

PP 3. The State Board upon finding that a contamination exists and is not being corrected, shall direct that action be taken by any state agency having jurisdiction.

The Governor of California appoints members of the nine regional boards, each board to have:

a. One person associated with organizations dealing with water supply, conservation or production.

b. One person associated with irrigated agriculture who is owner or manager of a farm in the region.

c. One person selected from persons acting in an executive or administrative capacity in industries producing industrial waste in the region.

d. One person associated with the municipalities in the region.

e. One person associated with the counties in the region.

The best and easiest way to indicate the duties of the Regional Boards would be to quote from portions of the State Water Code which states pollution is impairment of the quality of the waters of the state by sewage or industrial waste to a degree which does not create an actual hazard to the public health, but which does adversely and unreasonably affect such waters for domestic, industrial, agriculture, navigational, recreational or other beneficial use. The duties of the boards as taken from the law are as follows:

(13052) Each regional board, with respect to its region, shall:

(a) Obtain co-ordinated action in the abatement, prevention, and control of water pollution and nuisance by means of formal or informal meetings of the persons involved;

(b) Encourage and assist in self-policing waste disposal programs for industry, and upon application of any person shall advise the applicant of the condition to be maintained in receiving waters into which the waste is being discharged;

(c) Require any state or local agency to inspect and report on any technical factors involved in water pollution or nuisance;

(d) Request enforcement of laws concerning water pollution or nuisance by appropriate federal, state and local agencies;

(e) Formulate and adopt long-range plans and policies with respect to water pollution control within the region;

(f) Recommend to the state board projects for the reduction of water pollution which the regional board considers eligible for any financial assistance which may be available through the state board;

(g) Report to the state board and appropriate local health officer any case of contamination in its region which is not being corrected.

(h) File with the state board, at its request, copies of any official action with respect to any particular case of actual or threatened pollution.

(i) Have the power to require any state or local agency to obtain and submit analyses of well water.

(13053) Each regional board shall prescribe requirements relative to any particular condition of pollution or nuisance, existing or threatened, in the region.

(13054) Any person proposing to discharge sewage or industrial waste within any region, other than into a community sewer system, shall file with the regional board of that region a report of such proposed discharge. The reporting of a discharge of sewage from family dwellings in any area may be waived by the regional board. The regional board, after any necessary hearing, shall prescribe requirements as to the nature of such discharge with relation to the conditions existing from time to time in the disposal area or receiving waters upon or into which the discharge is proposed and notify the person proposing the discharge of its action. Such requirements may be revised from time to time. After receipt of such notice, the person so notified shall provide adequate facilities to meet any such requirements with respect to the discharge of sewage and industrial waste.

(13064) No order issued under the provisions of this article shall specify the design, location, type of construction or particular manner in which an operation causing or threatening to cause a condition of pollution or nuisance is to be corrected, and the person so ordered shall be permitted to correct the condition in any lawful manner.

It is quite apparent that the law is objective and that all parties interested in the water problem are represented. As an industrial member of one of the regional boards, your author has found the discussions of water problems very objective in most cases. There are those who wish to make industry clean up its effluent to better quality than the influent. There are still others who feel that they have an inherent right to do as they please with the water they use. These latter two types of individuals are the exception, rather than the rule. At a recent hearing of the regional board, 70 people were present, many of whom spoke their thoughts on the subject under consideration. Such attendance at a public hearing on a technical subject is an indication of the interest displayed in the subject.

The location of an industry or city in a water shed can, and does, govern the effluent requirements. A plant on the ocean where beaches must be protected for their intended use usually has a liberal effluent requirement. Whereas, a plant located on head waters of a basin would have stricter requirements in order to make receiving waters usable by others down-stream.

Any industry planning on locating in California should make a thorough inquiry into the following items:

Figure 1 — Effluent of plant is ponded.

1. Quantity of water available for both immediate and future needs for the type of plant. In many cases changes of operation and the use of recovery equipment can materially reduce the water requirements.

2. Quality of water available for the intended use. The chemical composition of the water determines the number of times the water can be recycled before it must be discharged as unsuitable for further use as a coolant. This would be because its concentration was causing deposition on lines and coolers. If the chemical composition is such that chemical treatment will remove some of these solids economically, greater use of the water can be made and a relatively high total solid water could be used. On the other hand, if the salts cannot be removed, and the same salts are considered detrimental to the receiving waters, a very low total solids may not be possible.

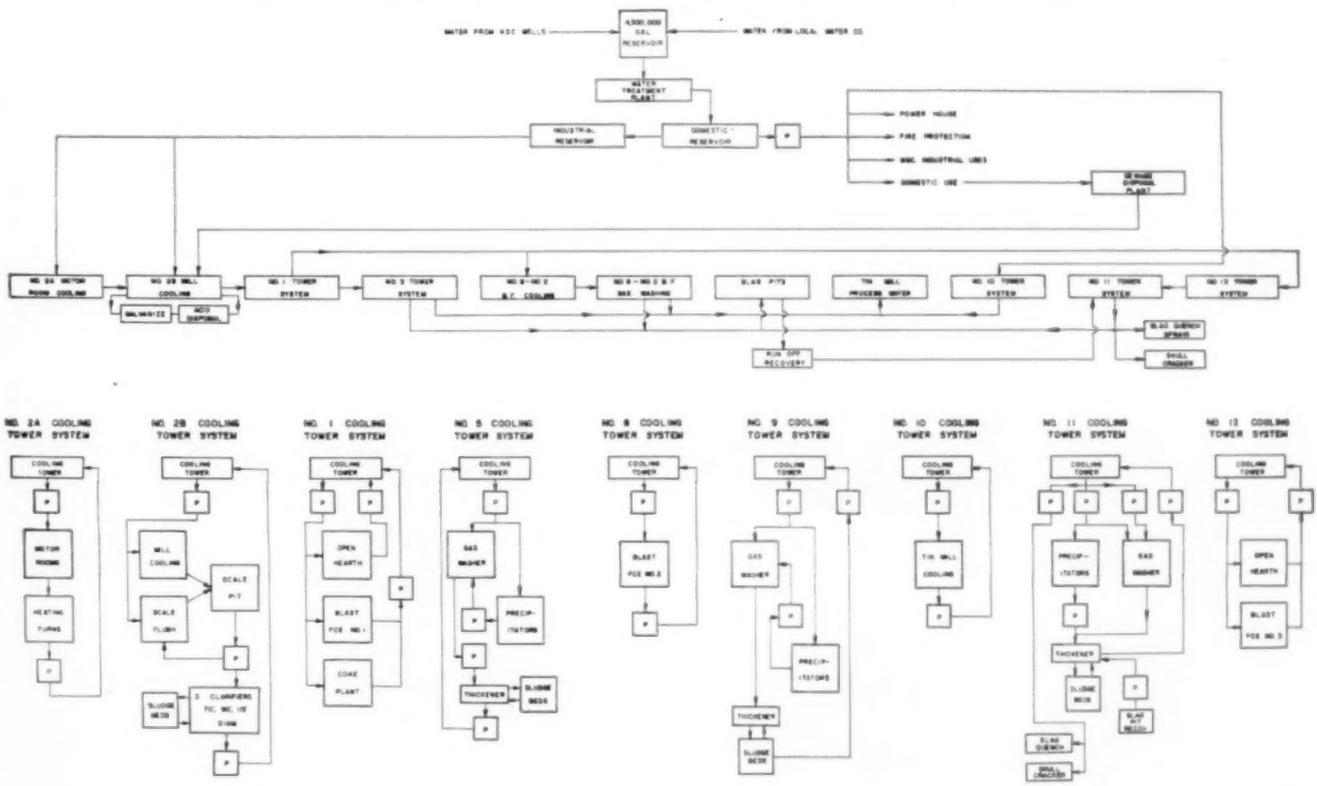
3. The quality of the effluent produced must be checked to determine if it will be compatible with the receiving waters and their intended use. If the receiving waters or subsequent receiving waters are for domestic use, the standards set by the United States Public Health service and the hardness are usually the basis for standards set by the pollution boards. Should the receiving waters be used for agricultural use, total dissolved solids, pH, sodium percentage, chlorides, boron, oil and fluorides receive considerable attention. Receiving waters for industrial use usually involve total solids, pH, and other elements depending on the type of industry affected.

4. The quantity of the effluent may be affected by the disposal means available. If a sewer with the carrying capacity is available and a treatment plant capable of carrying this load, the problem is usually solved. In some cases, such facilities are not available, and it is necessary to use ponds. The type of soil, the character of the underlying water, the location of the ponds with respect to residential property, and the character of the effluent when exposed to air and soil may present problems to be solved.

5. Site of plant may be determined by the effluent of that plant. If the effluent can be treated economically to satisfy the requirements for the area, the problem becomes quite simple. However, if the effluent cannot be properly treated, then the only recourse is to find a location where the requirements are not as high; connect to an outfall if available; or as a last resort, locate on the ocean with your own or other available facilities for disposal in the ocean.

The Kaiser Steel Corporation's Fontana plant is located near the headwaters of the Santa Ana River basin. Due to this location, the effluent of the Fontana plant is rather strictly controlled. The pond shown on Figure 1 is the basin which receives the plant effluent. These ponds have varying amounts of water in them. There are times when they are dry and still others when they hold considerable water. This latter condition

Figure 2 — Schematic layout shows water system at Kaiser Steel's Fontana plant.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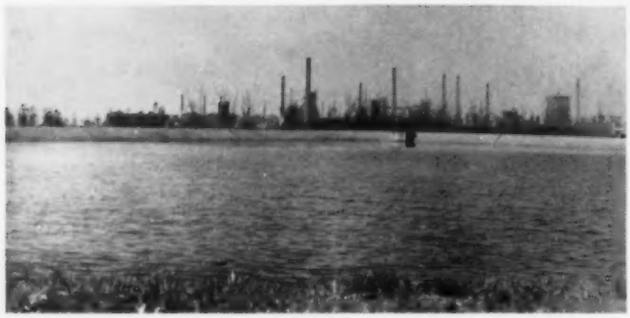

Figure 3 — Raw water reservoir has a capacity of 4,500,000 gallons.

often prevails during the rainy season when some of the run-off water from the plant is allowed to accumulate for percolating purposes. It is quite apparent that the Kaiser Steel plant has a relatively tight closed system. This system is shown on Figure 2. This is a revised layout which was discussed by Mr. George McMeans before the American Iron & Steel Institute in 1951, and by the writer before the California Industrial Waste Association in 1952. For those who have not had the opportunity to hear or read these papers, a short discussion of the system is given.

Water from a local water company, supplemented by two deep wells on the plant site, is delivered to a 4,500,-000-gal raw water reservoir (Figure 3). This reservoir supplies the water treatment plant (Figure 4) where it is treated for reduction of solids by use of a cold lime process using sodium aluminate and alum as coagulating agents. After carbonation with flue gases, the water passes three rapid sand filters to treated water reservoirs. The water from these reservoirs is pumped to the plant domestic system, boiler house, and fire protection. Make-up water to the industrial water systems flows by gravity to points of need. The total solids and pH of this water at various points in the system is noted.

Multiple systems have, and are being used at Fontana for water conservation and water pollution control measures. This is accomplished by passing water through a number of systems in series with the loss of one system becoming the supply of the following system. The systems are in sequence in order of quality requirements; the first system having the highest quality requirements and the last system, the poorest. The last system supplies water for such needs as cooling of slag and also spraying some raw materials for dust arresting. In the slag cooling process, the water is evaporated and the solids become combined with the slag mass.

Figure 4 — Water is treated for reduction of solids with a cold lime process using sodium aluminate and alum as coagulating agents.

Engineering work is in progress for a plant expansion. There will be a new operation which will liberate a large volume of hot and dirty gas. We are planning on introducing our poorer quality water into the gas stream for cooling purposes so the gas may be passed through dry type gas cleaning facilities. It is believed that by using the poorer quality water for this purpose, rather than introducing it into the general water system, over-all quality in our general system will improve.

This system has used approximately 1400 to 1600 gallons of water per ton of steel produced. This includes water for industrial, domestic and landscaping use.

It is not the intention of the writer to imply that this system is the Utopia of all water systems. There are control problems which require constant supervision. Many changes have been made to improve over-all performance of the system since the system was placed in service. Many more will probably be made as we gain more knowledge.

A 250,000-kw power generating plant was built near the Kaiser Steel plant several years ago. Limited local water was available to it, and it was necessary to use Metropolitan Aqueduct water for major uses. This water is Colorado River water containing about 750 ppm solids. The condenser water is recirculated over cooling towers and allowed to concentrate to about 3750 ppm. A blow-down of two gallons per 1000 kw is required to maintain the desired maximum concentration. This blow-down water, along with boiler blow-down and other undesirable waters is pumped through a 15-mile waste line to other waste facilities for a total of 67 miles to the sea.

This may seem like a tough way to run a power generation plant. It is, but those plants along the sea also have problems. Circulating ocean water through the condenser of a power generator assures an adequate supply, but there are major engineering problems associated. Where a harbor or some estuary is available as an intake, shelter from the shock of heavy storms is afforded. This saves the more expensive construction otherwise necessary. Wave heights along the exposed southern California coast occasionally reach 20 ft. Also, control of the growth of fouling organisms becomes a necessity. Both of these problems have been solved by this company by the use of separate submarine pipe lines for intake and discharge service extending out to about 30 ft water depth for the intake and terminating in a vertical structure tapped out below the greatest wave shock at between 15 and 20 ft below the surface. This gives an intake riser about 10 ft above the ocean floor which reduces sand intake.

Control of the growth of shell fish and other marine life which attaches itself to the insides of such conduits is obtained by alternating conduits in intake and discharge use so that each has the benefit of occasional flow of warm water to control start of such growth. A tem-

Figure 5 — This citrus ponding and spreading area is turned under regularly to eliminate offensive materials.

Figure 6 — Sewage plant uses spreading area through which effluent percolates underground.

Figure 7 — This plant reduces pollution problem by reusing water thus minimizing discharge.

perature rise of 25 to 30 F is sufficient for control.

A citrus processing plant located in the same water basin as the Kaiser Steel Corp.'s plant encountered a citrus by-product disposal problem that complicated the previous means of disposal. The disposal plant consisted of ponding and spreading on a 20-acre site a short distance from the plant. This scheme of disposal was not satisfactory because the solids settled on the bottom and edges of the pond. These solids fermented and produced obnoxious odors. The heavy loading of waste maintained wet pockets and patches of mat which was a breeding place for nuisance insects. As a result of data collected and observation of these unsatisfactory factors, a new 240-acre site was selected. The purchase of land, the laying of a 12 in. outfall, buildings, pumps, motors and machinery required an expenditure of over $250,000. The new area was divided into four tracts with each tract divided into six plots. The effluent was discharged into a single plot for 24 hr; then into the next plot for a day, etc., for a period of three months. The operation is then transferred to the next tract. The plots receiving discharge are disced regularly to turn under the mat which has formed on the surface (Figure 5). The individual plots when not used to receive the influent are cultivated and crops are grown. The yield of this land is greater than other adjacent land not so treated. These yields, however, do not compensate for the cost of operations.

Tests of the soil and underground water taken from wells indicates no ill effects because of the B.O.D. contained in the waste. The underground water tests indicate no serious detrimental effects caused by this operation. It is believed that this solution to the odor problem, as well as to the insect problem, is equal or better than those employed on neighboring farms.

A certain plant manufacturing a household appliance was chrome plating part of the appliance. The chrome waste was discharged into the sanitary sewer of the city. The sewage plant of the city was discharging its effluent on acreage near the sewage plant (Figure 6) where a fair portion percolated into the underground water. The chrome compounds appeared in water pumped from wells in the area. The condition was brought to the attention of the manufacturer and was corrected by having the chrome waste trucked to an outfall sewer which discharges into the ocean. This operation is more expensive, but it safeguards the water quality so others can reuse the water. Other companies are using this means of disposing of high fluorine, chromium, and arsenic wastes. There are still others who haul their waste to the desert or other spots where the danger of affecting water is remote.

Some companies on the coast line or navigable streams store their concentrated waste and periodically barge this waste to sea. The barges must be built to withstand corrosion and also must be seaworthy as it is often necessary to go ten to twenty miles off shore before the material may be dumped at a controlled rate.

The oil fields in the lower Santa Ana basin used to dispose of their brines after separation of oil in ponds. This threatened the underground water in the area. Today the use of ponds is about eliminated by the installation of outfall sewers to the ocean and also by pretreatment of the waste and injection into wells for water flooding which returns the water to the oil sand from which it came. It is reported that over 5,600,000 gallons of this waste are disposed of in one county each

day. The water is pumped into the wells under pressures as high as 2000 psi. The cost for pretreatment facilities varies from $50,000 to $100,000 per injection well.

A soap and edible fat plant in southern California (Figure 7) encountered a water supply problem as well as a pollution problem. A similar eastern plant discharged 8,000,000 gallons a day, whereas the Los Angeles plant discharges about 236,000 gallons per day into the sewer. This is accomplished by the reuse of water. The oils and greases are removed from the waste by separators. Acid wastes are neutralized by a batch mixing process before discharge to sewers.

A southern California brewery discharges its sanitary waste to the city sewage system. The high B.O.D. industrial waste of over 500,000 gallons per day is treated in a modern biofiltration sewage plant which includes clarifiers, biological filters and sludge digesters. The effluent is reclaimed by spreading on gravelly alluvium where it percolates to the subsurface aquifier used for local water supply. It is interesting that it requires about 13 gallons of good quality water to make one gallon of beer.

The writer has mentioned the dumping of waste into the sea or ocean. He did not wish to infer that this was the ultimate answer for disposal because there are many pitfalls. This has been best evidenced by outfalls in the southern California area that caused bad beach conditions. In some cases, untreated or partially treated sewage discharged through outfalls gravitated to the shores rendering beaches unsafe for bathing due to scum and bacteria count. The outfalls in some cases were too short for the effluent discharged, the contour of the ocean floor, the ocean currents, and for the wind pattern. In some cases it was necessary to extend outfalls while in still others it was necessary to treat the waste before discharge to the outfall.

There are countless other approaches to the pollution problem. Each is governed by the type of waste; the discharge requirement dictated by the location of the operation; and the ultimate use of the waters receiving the pollution. A study of records indicates there are very few cases where the plant which treats its effluent for pollution control realizes any immediate economic return on the investment for facilities or the cost of the operation. In most cases the use of water is curtailed by making better use of the water to reduce the disposal costs. In some cases the inverse is true, where quality water is scarce and expensive. In 1950 it was estimated that 90 per cent of water for all beneficial purposes was used by irrigation, leaving only 10 per cent for domestic and industrial use. It is believed this ratio will ultimately change to 80 and 20 per cent with industry using a small portion of the 20 per cent. It has also been estimated that southern California will need additional supplemental water by, or before, 1975. The California Plan is being developed and it is hoped that understanding and agreement can be reached at the legislative level to permit the start of this or other similar plans.

The water problems encountered in southern California are probably unique as compared to the rest of the country. They call for effective planning, for without this effective planning ultimate disaster will result. It is hoped that the California law which has representatives of all phases of water interest administrating the law will eliminate or reduce future problems to a minimum. The approaches used by industries and others in California may serve as a guide to those more fortunate at present, but who may encounter similar or related problems in the future.

DISCUSSION

PRESENTED BY

R. S. COULTER, Assistant to Vice President, Bethlehem Pacific Coast Steel Corp., San Francisco, Calif.

H. I. RIEGEL, Superintendent, Utilities Dept., Kaiser Steel Corp., Fontana, Calif.

R. S. Coulter: Fresh water is California's "gold"—and as such is a scarce commodity to be conserved and distributed to insure its maximum and most beneficial use. Mr. Riegel has amply emphasized this fact in his very interesting and informative paper. Hence, I will confine my remarks to the Kaiser Steel Corp.'s water usage.

We can all agree that Kaiser Steel Corp. has done an outstanding job in their use and reuse of water, particularly when it is realized that the average integrated steel mill located on a river or lake uses about 65,000 gallons of water per ton of steel produced without benefit of recirculation. This is an impressive figure when compared with the net consumption of 1400 to 1600 gallons per ton mentioned by Mr. Riegel, representing the make-up losses due to evaporative cooling, percolation in the ponds, slag cooling and final disposal.

The amount of water recirculation and recooling required by the Kaiser Steel plant water systems implies a relatively high capital investment in auxiliary pumps and sumps, cooling towers, clarifiers, treatment facilities, return pipe lines, etc.—equipment that is not always found necessary in a steel plant favored by unlimited supply of water. It would be interesting to develop comparative figures of capital and operating costs for water per ton of steel using a Kaiser type system vs the more conventional systems of primary pumping only. I wonder if Mr. Riegel would care to comment on this in a general way?

Mr. Riegel has mentioned that a new operation contemplated in their current expansion program anticipates the generation of large volumes of hot dirty gases. These gases are to be cooled by introducing poor quality water into the gas stream, thus expecting, as a by-product benefit, an improvement in the general system water quality. This, of course, would have to be at the expense of adding a corresponding quantity of new make-up water which is already in short supply.

I would be interested in knowing if the decision to cool the hot dirty gases was based primarily on a desire to improve the general system water quality or simply on the necessity for cooling hot gases to a point suitable for use in dry cleaning equipment. What I have in mind is, if it is not necessary to improve water quality, could the plant heat balance be improved by maximum useful employment of a heat exchanger for cooling the gases? Presumably, dry cleaning of the gases anticipates the

use of an electrostatic precipitator in which event the gases, no doubt, would have to be conditioned with water and if so there would be little water saved by the installation of a heat exchanger.

It is noted that the so-called multiple water systems in use at Fontana have as objectives not only water conservation, but water pollution control. In the matter of water pollution control, I wonder if Mr. Riegel would care to comment on the amount and character of effluent finally disposed of as unfit for any further use to the steel plant and how it is disposed of to minimize water pollution. In other words, what part of the 1400 to 1600 gallons per ton of make-up water mentioned in the paper is finally discarded; what would be its typical composition; and what is done with it?

H. I. Riegel: Mr. Coulter has submitted some very interesting questions. I will try to answer them in order.

The first question was, "What are the comparative capital and operating costs of the Kaiser type system vs the conventional system of primary pumping only?"

To give an accurate appraisal of the relative cost is almost impossible unless a person were to have two specific installations for comparative purposes. He would then have to take into consideration such variables as quality of water, the general plant layouts and others. Assuming the Kaiser Steel Corp. plant at Fontana were on the shore of a lake with good quality water and just a nominal amount of pollution control was required, it is my opinion that the water system capital would be about one third of our investment.

As for operating cost, we use approximately 10 per cent of the plant power for pumping water. This is because of the return pumping, the pumping over cooling towers, the power for towers and clarifiers, as well as other reclamation facilities. The operating cost is approximately of the same magnitude as the capital cost; namely, three times the primary pumping system. There are some factors favorable to our system which are hard to evaluate. We do not have fish or the debris which are usually associated with storms and their effect on bodies of water. Generally, our water quality is more uniform and the daily routine of blowing out coolers has become almost a lost art. This saving of time should be taken from our water charge to arrive at a true cost picture.

The second question was "What were the considerations in arriving at the use of poor quality water in a new operation under construction?"

The first consideration was the use of waste heat boilers for this operation. It was found, however, that the steam produced would be intermittent, and in order to balance the rest of the steam system, it would be necessary to swing the load on other boilers. As an alternate to swinging the steam load on other boilers, we could auxiliary fire the waste heat boiler. If we fired the waste heat boiler, the swing then would be transferred to the fuel system and another poor situation would result. Further, the automatic control on the waste heat boiler would be quite complicated and the efficiency of the boiler very low compared to conventional boilers.

The use of water for gas cooling was considered as an alternate and was found to be simpler, safer and less costly. A study of our water system indicated we were at water quality limits in some of our systems. The added production facilities would result in water quality poorer than desired at many places. We found that by disposal of the poorest quality water in the manner mentioned, we should be able to take the increased load on the water system without going beyond the practical quality limits found by past experience.

It has been a case of the overall evaluation indicating the present approach was best for this application. The overall operation should use less make-up water than we would have used with steam generation.

Mr. Coulter's third question has been partially answered by the illustration showing the disposal pond. Presently, the poorer quality waters are sprayed on the hot blast furnace slag. The water is evaporated, allowing the solids to remain. The solids appear to combine with the molten slag and leaching tests of the slag indicate the resultant water to be of acceptable standard for the area. The poorer quality waters are the boiler blowdown, the zeolite process regenerative effluent, the alkali waters from electrolytic cleaner, and blow-down from the blast furnace gas washing system. These waters run between 1000 and 2500 ppm solids with our main concern centering around the sodium bearing wastes. We have about 500 gpm of this combined waste from the general system, which is evaporated out on the slag.

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The Steel Industry In India— yesterday, today and tomorrow

By E. T. WARREN
President
Tata, Inc.
New York, N. Y.

. . . . present five-year plan in India will result in a steel industry with a rated capacity of 6,000,000 gross tons . . . . of this 3,000,000 tons will be in three new plants under construction, each of which will have a capacity of about 1,000,000 tons. The other 3,000,000 tons will be made available through private enterprise . . . . the competition between private and public-owned steel companies in the next few years will be an interesting thing to watch . . . .

▲ WITHIN the confines of the great triangular Indian Peninsula lie vast tonnages of iron making materials. In the provinces of Bihar and Orissa, lying to the west of Calcutta, there are practically 8,000,000,000 tons of rich hematite ore. The reserves in all of India can well be 20,000,000,000 tons.

These large amounts of ores are still there although they have been used to make iron over a period of the last two or three thousand years. True, the first two thousand years production of "Wootz Steel," of Damascus Steel and of "Jungli" iron undoubtedly did not consume as much ore as is now smelted during one day in the United States. Also true, that the tonnage consumed in and exported from India since the inception of the modern furnace is relatively very low. However, new ore discoveries and new reserve estimates each year greatly exceed annual consumption figures.

Coal reserves are likewise enormous, and at present are estimated at over 4,500,000,000 tons of which a possible third is of coking quality. Manganese ore is to be found in all of the same general regions that iron ore is found, and this valuable raw material has been exported from India over a period of the last fifty years. Limestones and dolomites are plentiful.

None of these materials are very remote from any of the others; a real steelmaker's dream. The Indian, the aborigine, has known the art of converting these materials into usable metals and he has reduced these rich ores since before the time of Christ, even as it is being done today, by forcing air by means of a blowing apparatus through a blowpipe and tuyere into a cylindrical refractory shaft furnace filled from the top with alternate layers of hematite ore and a solid fuel. In other words, our modern 2000-ton blast furnace practice is virtually nothing more than a great-great-grandchild of the ancient Indian jungle furnace practice.

Over and above this, they knew something about the art that is lost and which we do not understand today. For an example of this, take a trip to Delhi and visit the famous Iron Pillar, erected in the year 410, or over a thousand years before Christopher Columbus was born. It stands there, 24 ft high, tapering from 16 to 12 in. in diam and weighing over six tons. In its homogeneous entirety—hieroglyphics, lotus-flower cup and all—it is as rust-defying as it was those 1500-odd years ago.

The historian knows its history, the chemist knows its analysis, but no one today knows the secret of its making. If this six-ton pillar was the product of the known jungles furnaces which require eight hours blowing to produce 20 lb, it would have necessitated the tapping of 700 of them simultaneously—and then? One also wonders if this great iron monument was made by private enterprise, by public enterprise or by slave labor.

In the early 1820's there was a British civil servant by the name of Josiah Marshall Heath. To those who have studied the early steelmaking history of England, he will be remembered as the one who claimed the invention of the use of manganese in the making of steel. It was only after a 15-year period of court litigation that

Figure 1 — Map of India shows location of steel plants in this country.

his rights were established—and then only after his death. It is said he died of a broken heart, not only caused by the questioning of his manganese claims, but by his many years of failure in endeavoring to produce and export pig iron from India that could compete with Swedish iron.

In the year 1824, Heath obtained a grant from the Governor of Madras for the establishment of an iron and steel industry. This plant was built at Porto Novo, which is several miles south of Madras on the Bay of Bengal. It came into operation in 1830 and at times produced as much as 40 tons a week, with the use of charcoal and a bullock-driven blowing engine. Charcoal was used because no other suitable fuel was known, and bullocks, because the boiler of his 4-hp blowing engine soon burst after going into operation. At the end of his first three-year period he ran out of money, but the Madras Government again stepped in and assisted financially. In another three years he was again in financial difficulties. Other vain periods of attempt were made until finally in 1850 a new company called the East India Iron Co. was formed with a capital of about £400,000. As the available forest capacity for charcoal around Porto Novo was limited, this company erected three plants several miles apart to aid the charcoal problem which was caused by needing $3\frac{3}{4}$ tons of charcoal per ton of iron, and a square mile of Indian jungle only produced 64 tons of charcoal a year. This company struggled for several years. Heath returned to England in 1857, the late sixties saw the last of production, and in 1874 the company was dissolved.

During the remainder of the century many attempts were made to produce commercial pig iron in Bihar and the United Provinces, but soon there were left standing only ruins of furnaces as silent witnesses to misguided efforts.

The one exception and the first iron and steel works to obtain moderate success was established in 1875 near the Jharia Coal Field region, 130 miles northwest of Calcutta. In 1890 this passed into the hands of the Bengal Iron Co. and furnaces were remodeled to make nearly 80 tons a day. This company had pipe foundries, made railway sleepers and miscellaneous castings. It was not until 1899 when a Major R. H. Mahon, Superintendent of the Government Ordnance Factory, issued a memorable report on the manufacture of iron and steel in India. In this report he said that to have a successful industry it would be necessary to make iron from coke—not charcoal. How true this was. So the era of modern ironmaking began in India about at the turn of the century.

The steel production era began for India during the year 1912. This year saw the first open hearth heat tapped at the plant of The Tata Iron and Steel Co. in the town of Satchi, 130 miles due west from Calcutta and at an elevation of about 550 ft above sea level. Fifty-odd miles away was a mountain of 60 to 65 per cent Fe ore. Sixty-odd miles away were the Jharia coal fields. Three miles away was the main line of the Bengal Nagpur railway running from Calcutta to Bombay. The station was called Kali Muti—meaning "Black Mud." In 1919 Satchi was renamed Jamshedpur, and the railway station, Tatanagar. Both were so named in honor and respect to Jamshedji Nusserwanji Tata, the founder of the House of Tata. Born in 1839, he was a Parsi, one of the Zoroastrian faith, a direct descendant of those who 25 generations before had fled Persia to escape Mohammedan persecution. Starting in textiles, he founded and expanded the House of Tata on the principals of the Avestan worded Parsi religious motto, "Humata, Huxta, Hvarsta" which translates into, "Good Thoughts, Good Words, Good Deeds."

Mr. Tata had become interested in the making of steel as far back as 1882. From then until his death in 1904, steel in India was one of his main projects. There were many hurdles to cross before that first heat was tapped in 1912. Some such hurdles were the overcoming of such statements as, "I know what private enterprise means! It means robbing the Government." This was made by Lord Lawrence, then viceroy. And another, "Do you mean to say Tata's proposing to make steel rails up to British specifications? Why, I will undertake to eat every pound of rail they succeed in making." This by the Railway Board's chairman. To date Tata has never robbed the Government and graciously never insisted that anyone eat their rails.

Then there were hurdles of license getting, grant getting, suitable prospecting, engineering, know-how and, of course, financing. Lord Curzon, the viceroy in 1899, was most helpful by having the mining and prospecting regulations changed. A trip to America bore fruit for the obtaining of "know-how." Neither England nor America were interested in financing any steel venture in India. The Tatas decided on a bold venture—to raise capital within British-owned India for a privately owned Indian company. The results of this venture are best described by the following:

"From early morning till late at night, the Tata offices in Bombay were besieged by an eager crowd of Indian investors. Old and young, rich and poor, men and women they came offering their mites, and at the end of three weeks the entire capital for the construction requirements—£ 1,630,000—was received, every penny contributed by some 8000 Indians. And, when later an issue of debentures was decided upon to provide working capital, the entire issue—£ 400,000—was subscribed for by one Indian magnate, the Maharajah Scindia of Gwalior."

The first stake was driven in 1908, the first iron cast in 1911. In 1912 the first steel was rolled in India.

The original steel plant consisted of:

One battery of 180 non recovery ovens.
One battery of 50 by-product ovens.
Two 350-ton blast furnaces.
Four 50/60-ton stationary basic open hearth furnaces.
One 300-ton mixer.
One 40-in. reversing blooming mill.
One 28-in. reversing rail and structural mill.
One 16 in. and two 10-in. hand bar mills.

In addition to building such a plant, in almost virgin jungle, it was necessary to also build a town to house people of all positions, from a foreign general manager to the aborigine laborers. Ancillary to the building of quarters, of course, was the building of roads, sewers, sewage disposal plant, water filtration plant, hospitals, stores, places of amusement and recreation.

With the advent of World War I, an ambitious expansion was started to raise the output from 49,000 to 163,000 ingot tons a year. Much of the required equipment for this expansion was lost during shipment due to submarine sinkings, and construction was seriously delayed. When completed several years after the war had terminated, the plant had been augmented by:

Two-hundred coke ovens.
Three additional blast furnaces.

Figure 2—Blast furnace and blast furnace gas holder are seen across one of the water cooling ponds at Jamshedpur.

Four additional open hearth furnaces.
One to three Bessemer convertor/3 tilting furnace duplex plant.
One electrical driven 40-in. blooming mill.
One electrical driven continuous 24/18-in. sheet bar and billet mill.
One electrical driven continuous 12-in. merchant mill.
One electrical driven 96-in. plate mill.
One sheet mill consisting of four hand mills and three mechanized hand mills.
One sleeper press plant.

During this period, three additional ore mines had come into operation. In 1916 the company began to produce ferromanganese in one of their blast furnaces. Not only did this preclude the necessity of importing, but enabled them to export, which was of great help to the wartime manganese situation.

The author does not think it is necessary at this time to go into detail about the Tata Iron and Steel Co.'s plant at Jamshedpur. Anyone interested will find a very excellent paper on this subject in the February 1956 issue of "Blast Furnace and Steel Plant," written by L. N. Collins who at that time was assistant general superintendent.

The War's close saw another blast furnace plant being built. This by the Indian Iron and Steel Co. at Hirapur on the East Indian Railway, nearer to coal than Jamshedpur but further away from the iron ore. Only a few miles away was the Kulti plant of the Bengal Iron Co. mentioned earlier, which was later absorbed by the Indian Iron and Steel Co. This two-furnace plant was engineered and erected by a company in Cleveland. A substantial portion of this iron was available for export.

The post war period saw another plant come into existence. The Mysore State Government which was always administered very ably and which was probably the most progressive of any of the Indian princely states, decided to enter the field of iron and steel manufacture. Knowing full well the long drawn-out failure of the "Heath Era" and also knowing that the Bengal and Tata companies had proven Major Mahon's prophecy about success in pig iron manufacture requiring coke instead of charcoal, they decided to go into the wood distillation business with pig iron only to be a by-product, giving them an outlet for their charcoal. In any case, both coke and coking coals were over a thousand miles away. In 1923, they brought this new Mysore State plant into operation at Bhadravati. It was not until late in World War II that the charcoal scarcity and the accompanying high cost necessitated transporting coke a thousand miles by rail in order to keep their blast furnace operating. This furnace still operates on various percentages of charcoal and coke, depending on conditions.

In the 1926–30 period they added a cast iron pipe foundry and increased the size of their blast furnace to 80-ton capacity.

Steelmaking did not begin here until 1936 when a small bar and merchant mill were installed. A 25-ton producer gas-fired open hearth furnace furnished the ingots. In 1942 another similar furnace was added. Having no blooming mill, the steel was bottom cast into one-ton ingots for direct rolling in the finishing mill.

Figure 3—"D" blast furnace at Tata Iron and Steel was put into operation in June, 1954.

In 1939 the Mysore plant went into the cement business and during the next five years added a structural fabricating shop, a refractory plant, a 3½-ton electric furnace and in Mysore City built a 6-ton-a-day ferro silicon plant.

It was during this period that the Mysore Steel Co. began to show a profit for the first time.

Soon after the close of World War II, they added a small narrow strip and wire rod mill, consisting of a 20-in. rougher, five 12-in. intermediate stands and three 12-in. continuous finishing stands with coilers. In addition there is a 10-in. looping rod mill with coilers. This addition necessitated the purchase of outside billets.

In 1949 a cast iron railroad sleeper foundry was added to the plant and in 1950 a 7000-ton per year ferrosilicon plant.

With charcoal availability becoming less every year and the cost of hauling coke a thousand miles becoming more expensive every year, Mysore decided to make pig iron by the electric furnace method. In 1948, the Jog Falls hydro station, not many miles away, had begun to produce thus making cheap electric power available. During 1952 they put into operation two

13,200-kva Tysland-Hole electric furnaces for the making of pig iron. These are 33 ft-0 in. in diam and stand 16 ft-7 in. high above the foundations. The furnaces are charged through nine chutes, three around each of the three electrodes. There are three 4400-kva single-phase transformers supplying the electrical energy. The gas, after being cleaned by wet tower scrubbers, goes to a 1,500,000-cu ft gas holder located a half mile away at the cement plant. This gas is of high CO content with a fuel value of about 260 Btu per cu ft. These two furnaces have an annual capacity of about 60 to 65,000 tons. Power consumed runs from 2500 to 2800-kwhr per ton of iron, and electrode consumption from 30 to 40 lb. Over one-half ton of fuel (coke and charcoal) is used per ton. These are all relatively high figures. They seem to have more difficulty in obtaining iron of uniform analysis than they do in their shaft furnace.

This little plant in the south of India is able to produce about 35,000 tons of ingots and nearly as much finished steel by purchasing outside billets. The Indian Government's steel plant expansion scheme will bring the finished capacity at Bhadravati up to 100,000 tons.

Before the advent of the first world war, India was importing about 50,000 tons a year of tin plate with the largest portion going into the making of kerosene and petrol cans for the Burma Oil Co. All during the war, thought was being given to the schemes for the manufacture of tin plate in India.

In 1920 The Tata Iron and Steel Co. and the Burma Oil Co. signed an agreement for financing an enterprise of this type. The Tin Plate Co. was formed with Tata Steel as a minority stock holder. The plant was built about three miles from the steel works at Jamshedpur at a place called Golmuri. Tata supplied the tin bars, electricity and water. A New York firm was awarded the contract for design and construction.

The plant was designed to produce originally 28,800 tons of black plate a year and was engineered for a possible expansion to 100,000 tons.

Figure 4—Indian construction does not have the advantages of all the highly mechanized equipment available to American industry. Under construction here is a new steel-melting shop.

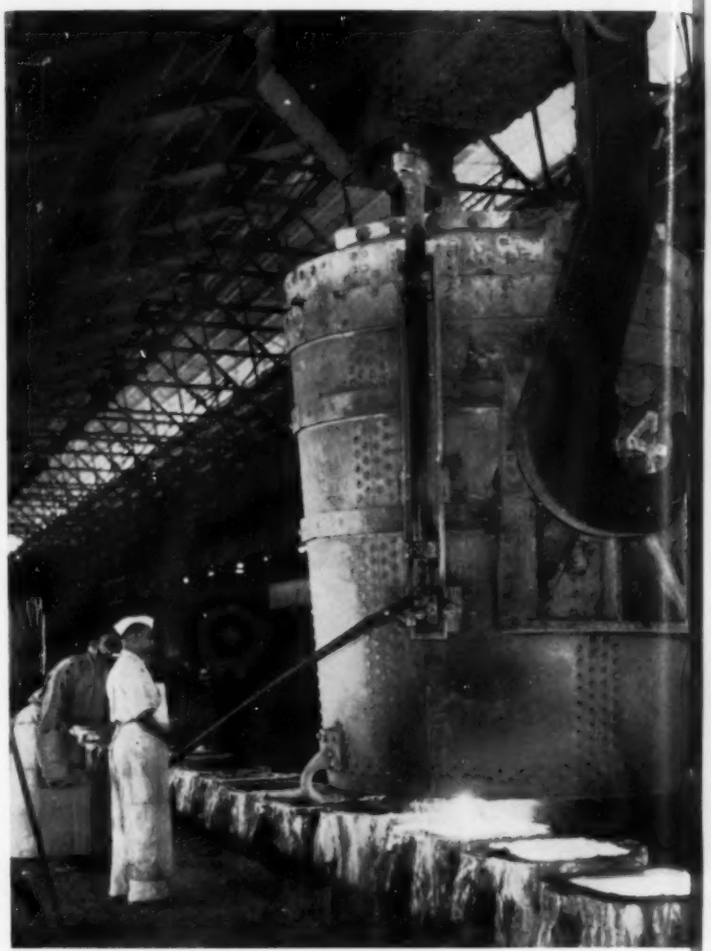


Figure 5—Heat is being teemed in No. 1 steel-melting shop.

Clearing for the site started in 1921, and although rolling in the first hot mill started in January 1923, it was not until December of that same year that the entire plant came into operation.

The original plant consisted of three units of two double mills with mechanical doublers and shears. The cold roll department had four sets of rolls, three in tandem.

To start up this plant, about 90 men were brought from South Wales, but by the end of 1923 only three Europeans were being used per mill per shift. For many years now this plant is operating with virtually all Indian personnel.

In the late 1930's The Indian Iron and Steel Co. decided to build a fully integrated steel plant. A new company was formed called The Steel Corporation of Bengal. The Indian Iron and Steel Co. was to furnish molten iron, power, gas and other sundry services to the new company.

An English company was appointed as the design and construction engineers. The new plant was located alongside of the old blast furnace plant at Hirapur without even a fence separating them. Hirapur is located near Asansol about 150 miles northwest of Calcutta on the old East Indian Railway.

This steel plant was equipped with an open hearth-bessemer-duplex type steel melting shop which included an English type active mixer. The mills consisted

of a blooming mill, a 34-in. mill for sheet bar, rails and medium sections, an 18-in. mill for smaller sections and mechanical hand type sheet mills similar to the ones at Tata.

They roll beams and channels up to 10 in. and angles up to 6 x 3 in. and in the smaller mill, beams and channels up to 5 in. angles up to 4 in. rounds up to 2⅝ in. in addition to small flats and squares. The annual capacity was rated at about 300,000 tons of finished steel.

In addition to these three integrated steel plants, there are probably nearly 150 rerolling mills scattered all over India. The production of the majority of these are reinforcing bars, light sections, narrow strips, hoops, etc. With the exception of the few larger plants, salvaged scrap is used for rolling.

The two largest rerolling plants are operated by the Tin Plate Co. of India—already spoken of—and the Indian Steel and Wire Products Ltd. The latter is also located near The Tata Iron and Steel Co.'s plant at Jamshedpur. Billets, power and water are purchased from Tata's. This company was incorporated in 1935 with an authorized capital of Rs. 5,000,000 ($1,050,000). At the present time, the authorized capital is Rs. 20,000,000 ($4,200,000). It is entirely Indian owned. They manufacture steel rods under ½ in. in diam, annealed and galvanized wire, hard bright wire and barbed wire, nails, bolts, nuts and rivets; telegraph, telephone, signal, bead, high tensile and stranded wire. Their annual capacities at present are:

Rods under ½ in.	72,000 tons
Wire mill	75,000 tons
Galvanizing	15,750 tons
Bolts, nuts and rivets	7,320 tons
Nails	24,000 tons
Wire rope	4,320 tons
Coiled Springs	1,800 tons

They are working on an expansion and modernization plan at the present time.

During the World War II period of 1939–45, the only major unit that was added to any of the steel plants in India was a wheel, tire and axle plant at Tata's Jamshedpur plant. This was put into operation in 1942 with an annual rated capacity of 10,000 tons of finished product. Wheels and tires are made in an Edgewater mill after being pressed in a 4000-ton press. The capacity of the plant has been gradually increased up to about 30,000 tons per annum.

At the end of hostilities and during the post war period of political and labor trouble caused by India's drive for independence, the steel companies were in a state of uncertainty as to where and how to expand. The Tata Iron and Steel Co. engaged a Cleveland, Ohio, company to make a technical survey of their existing plant and to make recommendations for additions and future development. After studying both local and Indian-wide conditions they recommended a capacity expansion at Jamshedpur of from about their 850,000 gross tons of finished steel per year to 1,300,000 gross tons. In this program there was to be an additional blooming mill, a new continuous strip mill and a new skelp mill. This report was submitted in the spring of 1947. In the fall of that year, the British turned over the reins of government to the Indians. Then came another period of uncertainty.

The new Indian government soon began to talk of mixed economy—industry was partly to be state-owned, partly privately owned. From then on, one began to hear and read of the government going into the steel business. The private companies began to mark time.

In early 1948 the new Indian government appointed three different firms of consulting engineers to make three distinct comprehensive studies of the Indian steel situation and to make recommendations. Two of the companies were American, the other was English. At that time, the Indian government had fairly well made up its mind that they wanted to build and operate one or more steel plants. These firms were all to recommend the establishment of one steel plant of 1,000,000 gross ingot ton capacity capable of being duplicated, or the establishment of two steel plants of 500,000 ton capacity each, and capable of being doubled.

All three companies differed somewhat in their estimates of future demands for steel products in India; they all reached the conclusion that there would still be a deficit of 1,000,000 tons of steel a year in either case.

The different consultants suggested different types of products to be rolled, and in different quantities; thus estimated capital costs were over a wide range, ranging from $198 to $294 per gross ton of salable steel.

All of the consultants agreed the first plant should be in the Central Provinces and the second plant in Orissa. The choosing of the Central Provinces is quite understandable as it was at this location that the Tata Iron and Steel Co. had first expected to establish their original plant at the beginning of the century. It was only the finding of other ore equally as good, nearer the coal fields and nearer the Calcutta market that brought about an eleventh hour switch to Jamshedpur.

After all the reports had been submitted, the two private steel companies were asked by the Government to comment.

After studying the reports, recommendations were made to Government. In these, it was the consensus of opinion that the expansion of the new steel plants should be carried out in pre-conceived stages and in an orderly manner. They recommended:

Stage 1. The first plant of 500,000 gross tons of finished steel capacity should be erected.

Stage 2. This plant should be expanded to 1,000,000 capacity.

Stage 3. The second plant of 500,000 tons capacity to be erected at one of the other sites.

Stage 4. This plant should be expanded to 1,000,000 tons capacity.

In 1949 the Government asked all three of these companies to quote a turnkey job for the design and erection of a 500,000-ton plant. After these tenders had been studied, the question of financing became a stumbling block and no positive action was taken for some time.

In early 1953 the Japanese began making overtures to India for a joint venture of building a blast furnace plant in India with the Japanese owning 49 per cent of the capital and having the privilege of exporting a certain percentage of the pig iron to Japan. At that time

they were buying iron ore from India and were badly in need of either ore or pig. This scheme never materialized.

After overtures had been made to the International Bank for Reconstruction and Development, a technical mission was sent to India early in 1953. They suggested to the Indian Government that if only a 500,000 to a 1,000,000-ton expansion was needed it could well be done by Tata at Jamshedpur and by the Indian Iron and Steel Co. at Burnpore. If a totally integrated plant was to be built, this mission's first choice was in Orissa Province. This report was submitted in March of 1953.

Later in 1953 without further request for advice from either of the two experienced steel companies, the Government signed a contract in Germany for the engineering and erecting of a 500,000-ton steel plant with a Krupp-Demag combine. In December of that year, a Government-controlled company named The Hindustan Steel Ltd. was formed with a capital of $100,000,000. Twenty per cent of the shares were German held and they were to have two of the ten directors on the board. The German contribution to the financing was to be in the form of engineering. It was not until early 1954 that the Germans recommended and had accepted their proposal for the location of this plant at Roerkela in Orissa. During their studies, much pressure was exerted by both Bengal and the Central Provinces to have the plant located in their territories.

Before the German project was finally accepted it was March 1956. This delay was due to India's decision to increase this to a 1,000,000-ton plant, after considerable work had been done on the engineering of the 500,000-ton plant.

The final plant and the one that is under construction today consists of:

Three batteries of 78 coke ovens.
Three blast furnaces of about 1,000-ton size.
An Austrian type tap-blown oxygen converter steel shop.
A hot strip mill.
Accompanying cold mills, galvanizing and tin plate equipment.

Although all bids were supposedly placed on a world-wide basis, all equipment that cannot be made in India is being purchased in Germany.

During this period, India decided to be the sole owner of this plant and they have taken over the German's financial interest in the company.

They hope to have this plant operating by the end of 1959.

In November of 1954, a team of Russian technicians came to India and within ninety days a preliminary agreement was signed with them for the building of a 1,000,000-ton plant. Their final report was submitted in December of that year and a contract signed.

The Russians estimated a value of $110,000,000 for the equipment they proposed to ship from Russian ports. They offered payment terms of twelve years' duration with an interest rate of only 2½ per cent per annum. They also agreed to accept payment in rupees or free sterling.

The Indian Government at this time left themselves a loophole to withdraw if the final project report was not found satisfactory, by a clause in the agreement which read, "In case the detailed project report is not accepted by the Indian Authorities, the latter undertake to pay to the Soviet organization all expenses in connection with the preparation of the project report subject to a limit of Rs. 80,00,000 ($1,680,000).

It is also of interest to note the method of payment to the Soviet organization for their services. "The Indian Authorities shall pay to the Soviet organization for their services including the detailed project report, and the cost of detailed working drawings of all plants, shops, communications within the works boundary, power supply, water supply, gas supply, buildings and foundations, and erection drawings and spare part drawings for the machinery and equipment Rs. 2,50,-00,000" ($5,250,000).

In all other respects, the contract was more or less along the lines that would be expected between any engineering firm and a company. They have no financial interest in the company.

The site of this plant is at Bhilai in the Central Provinces (now called Madhya Pradesh) and as was said before, is in the vicinity of where the first-known rich ore was discovered in India and where the Tata Iron and Steel Co. had first expected to build their plant. This plant's raw materials will come from ore mines located about fifty miles to the south and from new collieries about 65 miles to the northeast. The plant will be made up of:

Three batteries of 65 coke ovens each.
Three blast furnaces of 1135 tons per day rating.
One open hearth shop.
One blooming mill.
Finishing mills for the rolling of heavy and medium structural shapes, rails, sleepers and merchant bars.

They expect to put this plant into operation in 1959.

In February 1956, after several years of negotiation, an agreement was signed with a British company for a third 1,000,000-ton plant at Durgapur in West Bengal, a little over 100 miles from Calcutta on the main Calcutta-Delhi-Bombay Railroad.

This British company is newly formed and made up of various firms which engineer, manufacture steel plant equipment and erect steel plants. The British firms involved in this company are: The Cementation Co. Ltd., Simon Carves Ltd., Davey and United Engineering Co., Head, Wrightson and Co. Ltd., and Wellman Smith Owen Engineering Corp. Ltd.

In addition there are several structural steel companies and several electric supply companies involved.

This plant will consist of:

Three batteries of 78 coke ovens.
Three blast furnaces of 1250 tons per day rating.
Three open hearths.
Mills for the rolling of medium and light sections and a wheel and tire and axle plant.

The British are putting up $84,000,000 of which commercial banks are lending $32,000,000 at one per cent over the bank rate, and the remainder is being put up by the British Government with an administration charge over and above the borrowing rate.

They hope to have this plant in operation about 1960.

At this time, or within the limit of India's second

Figure 6—The 40-in. blooming mill is a key unit at Jamshedpur.

five year plan, the Indian Government owned and operated steel plants hope to be producing 3,000,000 long tons of ingots. Their original estimated capital investment for this tonnage was about $731,000,000, or $265 per long ton of ingots. Today they estimate $900,000,000 or $300 per long ton which is made up as follows:

German-built plant at Roerkela...	$357,000,000
Russian-built plant at Bhilai.....	275,000,000
British-built plant at Durgapur...	268,000,000
	$900,000,000

To train personnel for these plants, The Tata Iron and Steel Co. has been assisting by the training of graduate engineers and skilled operatives for the Government. Also recruits for the new plants will be given a six-week orientation course at Jamshedpur before being sent abroad for further training. From 80 to 100 of these have been sent to Germany. From 90 to 100 have gone to Russia. Britain has agreed to take 300. The Ford Foundation and the American Iron and Steel Institute have made arrangements with various U. S. A. steel companies to train about 200 of these boys in this country. Australia and Canada are also taking a few. In other words, the steel industry in the private sector of the world, including India's own private sector, is training hundreds of Indian youths to become steelworkers in India's Government-owned steel plants. Russia is doing likewise.

What has been going on in the private sector during this expansion program? When the Indian Government formulated their second five-year plan which was to begin in 1956, they decided that a production of 6,000,000 long tons of ingots per year could be consumed in the country by the end of this period. It was then that they planned to build three 1,000,009-ton plants. To attain the 6,000,000 ton goal it was necessary to have the plants in the private sector increase their production to 3,000,000 tons. Mysore's output being very small, Tata was asked to plan for 2,000,000 tons and the Indian Iron and Steel Co. Steel Corporation of Bengal for 1,000,000 tons.

The Steel Corporation of Bengal was transferred to and amalgamated with The Indian Iron and Steel Co. on January 1, 1953. Having agreed to this amalgamation, the International Bank for Reconstruction and Development agreed to loan them $31,500,000 or the equivalent thereof, for an expansion scheme to enable them to increase their ironmaking capacity from 640,000 to 1,400,000 tons and their finished steel from 350,000 to 700,000 tons. This project included:

Two new batteries of 78 ovens with a corresponding increase in the by-product plant.
Two new blast furnaces of 1200 tons per day capacity.
One new 25-ton converter.
Two new 240-ton tilting open hearths.
Four new soaking pits.
An extension to the finishing ends of the 34-in. and 18-in. mills.
Expansion of ancillary services.
At their other plant located at Kulti, they have:
a. Modernized the blast furnaces.
b. Installed gas cleaning.
c. Installed a 5,000-kw steam turbine to permit the cleaned gas to be utilized.

This project was estimated to cost about $74,000,000 of which the $31,500,000 borrowed from the International Bank for Reconstruction and Development only covered the foreign exchange element. This bank loan is guaranteed by the Indian Government and will be amortized over a period ending in 1967.

Before these expansions were completed, the Government requested this company to increase their finished steel output from 700,000 to 800,000 tons a year. To obtain this, the newest project entails:

The adding of two stands to their billet mill to enable them to roll 9 x 9-in. billets instead of 7 x 7 in.
To add one stand to their 34-in. structural mill in order to increase their rail and section tonnage and allow them to roll wide flange beams up to 10 x 10 in. and standard beams up to 20 x 7 in.
A new bar mill with an annual capacity of 180,000 tons.
A new 20,000-kw steam turbine generator.
Necessary auxiliary equipment.

To finance this they again turned to the World Bank who increased their original 1952 loan by $20,000,000. In addition to this it was necessary for them to issue new common stock in order to raise a further $7,500,000 equivalent. This loan also will be completely amortized in 1967.

The Tata Iron and Steel Co. who had already entered into a modest expansion scheme to bring their finished steel tonnage up to 931,000 tons a year, was also asked by Government to increase to 1,500,000 which called for an annual ingot tonnage of about 2,000,000 long tons.

As, of course, the Government had decided to put the strip mill in their own plant at Roerkela, Tata's original plans for a strip mill were abandoned and they were asked to increase their structural, rail, billet and bar output. To obtain this increase plus other necessary and desirable additions and improvements, it meant that a new capital outlay of nearly a quarter of a billion

dollars must be spent in this five-year period. The main items on which this money has been spent and is being used are:

Two new batteries of 26 coke ovens each.
The rebuilding of three old batteries.
Ore preparation and sintering plant.
One new 28 ft-0 in. blast furnace.
Seven new 200-ton open hearth furnaces.
Two new rotary kilns in the dolomite plant.
One 46-in. 2-high blooming mill with soaking pits.
One continuous sheet bar and billet mill.
One medium and light structural mill.
One Skelp mill.
One Fretz-Moon tube mill (partially owned by Stewart & Lloyds).
One electric ferromanganese plant located at the manganese ore mines.
Revamping of the present plate mill.
Revamping of the present merchant mill.
Revamping of the present structural rail mill.
One new refractory plant of 60,000 tons per year capacity.
One ferrosulphate washing plant for treatment of waste pickle liquor.
One slag/scrap recovery plant.
Ancillary equipment necessary for the above.

The above-listed projects are well under way and all of them should be in operation long before the present five-year period is finished.

Kaiser Engineers of Oakland, California, have a turn-key contract for about $130 to $140,000,000 of this work. The remainder of the projects have been engineered and erected by various firms including The Tata Iron and Steel Co. themselves.

To finance this entire project, the Tata Co. found it necessary to go outside of India, for the first time in their history, to borrow money. The International Bank for Reconstruction and Development was most receptive when approached and in June of 1956 a loan was granted by the bank to the company for the sum of $75,000,000 in various currencies including English pounds, deutsch marks and yen besides U. S. dollars. This loan bears an interest rate of 4¾ per cent and will be fully repaid by June 1971. Negotiations are being carried on at present for raising another $35,000,000 outside of India. The remainder of the capital necessary is coming from internal savings, an increase in the share capital by the issue of common stock, and local borrowings.

It might well be asked why these two old steel companies, who have for many years made cheap steel and cheap iron and who have always been able to sell all that they have produced, have found it necessary for the first time in their history to borrow money.

The answer to this is simple. The Indian Government not only sets the selling price but they take out of the profits enough to subsidize foreign imported steel so that the customer pays the same price for his steel regardless of from where it comes.

During the last war, finished steel prices were fixed by Government, and an Iron and Steel Control was created that dictated the rolling schedules and allocated the distribution of the finished product. This a rather common wartime practice. The only trouble is, they have never rescinded the procedure since the end of the war.

This Government fixes not only a "sale price" but a "retention price." The difference between these two prices goes into an "equalization fund." From this fund, foreign steel is subsidized. Although the difference between the retention price and the sale price varies, it recently amounted to about $25 a ton for use in the equalization fund. Thus if a certain category of steel is imported for an actual cost of $160 per ton and the sale price for this type of steel has been fixed at $140 a ton, the loss of $20 is made up by drawing from the equalization fund.

From 1944 through 1956 the Tata Iron and Steel Co. alone paid into this fund a sum of $85,000,000. If the company could have retained this amount for capital expenditure, foreign borrowings would not have been necessary.

Over and above this, the retention price has been fixed so that the companies can earn a gross return of only 8 per cent or a net return of about 3½ per cent on capital expenditure—not very attractive for enticing the participation of risk capital. Also it is totally inadequate for the building up of reserves for expansion.

At one period the Government allowed different retention prices for the different companies in order to make the profit per ton of steel equal regardless of costs. The higher the cost, the higher the retention price. This was discontinued in 1955.

What has been going on in India since they obtained independence is a political democracy, but an economic autocracy. This autocracy has been protested vigorously from many points within private industry.

Mr. J. R. D. Tata, in one of his annual speeches to the shareholders of the steel co. said:

"Our Government has adopted the concept of a mixed economy for the country, a concept which has found broad public acceptance and in which business and industry are anxious to co-operate. A mixed economy, however, implies the co-existence of state enterprise and free enterprise, and cannot mean a wholly state-dominated economy where the industrial class is temporarily tolerated and permitted to survive, pending further developments. A mixed economy can only function if there is within the community a balance of forces, with free enterprise operating as one of the autonomous forces pulling its weight alongside state enterprise, trade unions and other elements in society."

This concept is in a way recognized by many of India's top people. Mr. Nehru has said, "I think there is really no choice before us between having a private sector and allowing it and encouraging it to function, and not having it at all. It is foolish to have a private sector and then undermine it and prevent it from functioning. . . . I personnally think that even for the proper functioning of the public sector it is desirable to have a competitive private sector."

Mr. T. T. Krishnamachari, the former Minister of Commerce and Industry and now the Finance Minister, has said that there would be no nationalization for the sake of nationalization. There is, however, the sword of uncertainty perpetually hanging over the head of the private steel producer.

TABLE I

Proposed Distribution of Finished Steel Products among Various Producers at End of the Current Five Year Plan
Tons per Year

Product	Estimated demand	Existing privately-owned plants				Proposed government-owned plants			Proposed total production
		Tata Iron & Steel Co., Jamshedpur, State of Bihar	Indian Iron & Steel Co., Asansol, State of Bengal	Mysore Iron & Steel Works Bhadravai, State of Madras	Rerolling companies at various points throughout India	Being constructed by German engineers at Rourkela, State of Orissa	Being constructed by Russian engineers at Bhilai, Central Provinces	Being constructed by British engineers at Durgapur, State of Bengal	
Heavy rails and fishplates	265,000	135,000	100,000	...	...	...	100,000	15,000	350,000
Heavy structurals	485,000	110,000	110,000	10,000	...	...	100,000	80,000	410,000
Broad-flanged beams	75,000	...	40,000	...	...	...	75,000	...	115,000
Crossing sleepers	30,000	30,000	...	...	...	...	30,000	...	60,000
Sleepers	170,000	50,000	...	...	...	...	60,000	60,000	170,000
Medium and light structurals and rails	510,000	297,000	120,000	10,000	10,000	...	...	138,000	575 000
Deformed concrete bars	30,000	...	...	10,000	...	...	...	30,000	40,000
Rounds and flats, $\frac{1}{2}$-in. and over	780,000	144,000	160,000	38,000	420,000	...	245,000	140,000	1,147,000
Rounds and flats, $\frac{1}{2}$-in. and under	360,000								
Spring steel	30,000	4,000	...	2,000	12,000	...	...	12,000	30,000
Wheels, tires and axles	70,000	30,000	...	...	...	...	...	40,000	70,000
Tin plate	150,000	...	...	...	100,000	...	...	...	100,000
Plates, $\frac{13}{16}$-in. and over	300,000	100,000	...	...	...	200,000	...	...	300,000
Wire and wire products	100,000	...	...	5,000	95,000	...	...	...	100,000
Wire rope	5,000	...	...	...	5,000	...	...	...	5,000
Tool and alloy steel	10,000	...	...	2,000	2,000	...	...	...	4,000
Stainless steel	15,000	...	...	15,000	...	...	...	...	15,000
Hoops and box strapping	60,000	...	...	8,000	37,000	...	...	...	45,000
Forging blooms and billets	100,000	22,000	10,000	...	...	...	...	95,000	127,000
Hot-rolled sheets and strip	650,000	150,000	120,000	...	...	380,000	...	...	650,000
Strip up to 12 in.	60,000	42,000	...	...	...	40,000	...	...	82,000
Strip over 12 in.	145,000	...	...	...	...	100,000	...	...	100,000
Skelp (for tubes and pipe)	100,000	106,000	...	...	...	...	...	...	106,000
Total finished products	4,500,000	1,220,000	660,000	100,000	681,000	720,000	610,000	610,000	4,601,000
Semi-finished products	...	280,000	140,000	...	28,000*	...	140,000	140,000	(728,000)
Total rolled products	4,500,000	1,500,000	800,000	100,000	709,000	720,000	750,000	750,000	4,601,000**

* Semi-finished steel produced from scrap by re-rolling companies.
** Exclusive of the 728,000 tons of semi-finished steel consumed by re-rolling companies.
All figures are in long tons of 2240 lb.

You may be assured that the private steel producer in India has nothing of which to be ashamed. The Tata Iron and Steel Co. have without question the most highly paid and well cared for labor force in India. It has proven during two great wars how it can serve the nation and the war effort just as well as the steel industry has in Western countries. Profits have been plowed back into the industry, stock holders have received fair and consistent dividends, employees have shared yearly in large profit-sharing bonuses and the Indian Government's income from taxes and duties has been enormous.

Table I shows the allocated tonnages expected from the various steel producers.

During the coming decade, one of the greatest experiments in the steel industry is to take place—competition between publicly and privately owned steel companies. The rated capacities will be equal—3,000,000 gross tons in the private sector, 3,000,000 gross tons in the public sector. The selling price of similar products will be the same for both. With the increased output, foreign steel imports should drop to a point where the equalization fund could well go out of existence.

Theoretically, the private sector which is the experienced sector and which undoubtedly will be the lowest-cost sector (if treated on a parity with the public sector) should show the way for many years to come.

DISCUSSION

PRESENTED BY

T. A. BEDFORD, Vice President, Kaiser Engineers, Oakland, Calif.

T. A. Bedford: Mr. Warren has presented an excellent documentation on the development of the steel industry in India. We feel, of course, it is important for all of us to keep in touch with steel industry developments there and throughout the rest of the world.

Mr. Warren has given us quite a background of detailed information in his paper. He did not have time to touch on all of the details today. His paper will be found to be very interesting when it is published, and there is an opportunity to read some of the more detailed information it contains.

In some respects, we feel that Mr. Warren has been quite modest in his reference to the Tata Iron and Steel Co. and their part in the total expansion program in India.

By 1960, when he stated that three new plants would be added to the existing industry, Tata, at 2,000,000 tons annual capacity, will still be the largest single producer, and it also will have by far the broadest product line in India.

Our contract for the Tata expansion program was only started in December, 1955. The program has been forced to overcome a good many unforeseen handicaps. These handicaps primarily resulted from the Suez crises, which disrupted shipping from suppliers around the world, and the severe congestion in the Calcutta port. That congestion resulted from the very heavy imports of machinery and equipment for India's *entire* 5-year program.

However, we feel that we have gotten over these hurdles, and we are now scheduled to complete the program for the Tata Co. in mid-1958.

We have received very substantial support and cooperation throughout from the entire Tata organization. Jamshedpur is almost exactly on the opposite side of the world from Oakland, California, which is our home port. Coordination and communication problems are most severe when long distances are involved. Halfway around the world from the jobsite, our engineer responsibilities on this turnkey project include: specification, purchasing and transportation of equipment and materials, detailed design for all plant facilities, and coordination with construction activities of our overseas corporation, who will have received, by jobsend, about 100,000 tons of equipment and materials at the Calcutta port, transhipped it 150 miles west, installed it, and placed it in operation at Jamshedpur. The fact that we have solved these problems, thanks to the support and cooperation of the Tata organization, we regard as one of our real accomplishments.

. . . . between 1953 and 1956, Stelco increased the average production rate of the hot strip mill by 46 per cent without capital investment . . . . between 1954 and 1956 production rates was increased by 30 per cent without affecting mill time available for rolling plate . . . . increases were due to ingenious utilization of equipment . . . .

Operation of a Canadian Strip Mill

By R. J. BARRY

Superintendent, Plate and Strip Mill, The Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

▲ CANADIANS occupying a country 86,000 square miles larger than the U. S., including Alaska, struggling with a population of 16,000,000 people to gain a more prominent place in world trade and world affairs, at times become frustrated with the views of Americans. These remarks are contentious, but it is hoped they will be accepted in the spirit in which they are given. Both countries can take pride in the continued good will that exists between them. It is a pleasant contrast to other parts of the world of today and a condition one hopes will continue. It should be pointed out, however, that to maintain such good will there must be a full understanding of the problems of each country; such an understanding as is exemplified in the trade between the two nations. Experience of men in business tells them that your best customer should receive the most consideration. Canada is the United States' best customer as the United States is Canada's. However, in 1956, Canada bought $1,300,000,000 more than it sold the United States and that excess of imports over exports for 16,000,000 people is too much.

The present United States government policy of subsidizing farm product sales throughout the world, and the current demand for ever higher tariff on both manufactured material and natural resources entering the U. S. from Canada, must in the end adversely affect purchases from the United States. The result could be a falling off of trade between the countries and more isolationism which often, in the past, has been deterimental to countries.

The map (Figure 1) indicates the expansive but thinly populated country of Canada. The geographical factor of widely separated markets makes Canadians really hustle to be competitive, to make money and to expand.

This paper gives further particulars of one of the many expanding industries.

Figure 1 — Map of the Dominion of Canada shows the great distances between Hamilton, Ontario, and the major cities of the country.

The hot strip mill of the Steel Company of Canada includes a 110-in. 4-high plate mill used as a reversing rougher. Its basic equipment consists of the following elements:

a. Three slab reheating furnaces of the zone-controlled, triple fired, end magazine charged, end discharged type with an effective heating length of approximately 80 ft and a width inside the brickwork of 20 ft. Heating of the slabs in the heating zone is carried out by eight burners above the steel and six burners below the steel. The soaking zone is heated by eight burners spaced across the discharge end of the furnace. All burners are of the combination type for burning gas and/or oil. A single furnace has a rated (by the manufacturer) heating capacity of approximately 70 tons per hour.

b. A vertical edger or scalebreaker.

c. A reversing roughing stand with six possible speeds in each direction with a base speed of 35 rpm.

TABLE I

	Edger	Roughing stand	Continuous train stands					
			No. 1	No. 2	No. 3	No. 4	No. 5	No. 6
Driving motor, hp	500	5000	3500	3500	3500	3500	3000	3000
Work roll diam, in.		38.5	22.5	22.5	22.5	22.5	22.5	22.5
Speed of rolls, rpm		12/35/80	38.9/77.8	68.1/136.1	98.3/196.6	124.6/249.2	150/300	175/350
Speed of strip, fpm			229/458	401/802	579/1158	734/1468	883.6/1767.2	1031/2062

d. A continuous train with six 56-in. wide 4-high stands with scalebreaker and crop shears.

e. Two down coilers capable of producing a coil with an internal diameter of 22.5 in., a maximum external diameter of 48 in. and a maximum weight of 12,000 lb, or 378 lb per inch of width.

The powering and speed range of the various stands is shown in Table I.

The distances between different elements of the equipment, an item important for the estimation of the possibilities of the mill, are shown in Table II.

TABLE II

Furnace No. 1 (closest to rougher) to edger	86 ft 6 in.
Edger (scalebreaker) to roughing stand	30 ft 0 in.
Roughing stand to crop shear at No. 1 stand	290 ft 0 in.
Flying shears at No. 6 stand to pinch rolls at No. 1 coiler	290 ft 8 in.

Water at 1000 psi is used for descaling purposes at the roughing stand and the edger, both from the top and bottom sides of the slabs. Rolls are cooled with water at 40 psi on the roughing stand and at 70 psi at the pumps on the 56-in. continuous train with additional facilities now being installed for 100 psi at the mills. Bottom and top nozzles are used on the runout table to cool the strip and cover a total sprayed length of 132 ft. 4 in.

Both plate and strip are rolled in the mill, the strip covering a wide range of gages from 0.047 to 0.375 in. with an emphasis on the cold mill gages (0.07 to 0.09 in.). The same statement applies to the width of the strip rolled, the most frequent width being in the range of 34 to 36 in. with a maximum of 51 in. and a minimum of 18½ in.

The hot strip mill is serviced by a slab yard, 100 ft x 775 ft, with an estimated slab storage capacity of 20,000 tons (about 60 per cent of it is used for strip slabs) equipped with two overhead cranes (main hoist of 25 ton, auxiliary hoist at 15 ton) and two semi-gantry cranes with a lifting capacity of 7.5 tons.

The slab reheating furnace No. 3 went into operation in August 1952 and since then no further additions or changes in the basic equipment of the mill have been made. Thus, 1953 was the first year of operations on a basic equipment as it is available today.

Figure 2 shows the total tons rolled in the mill as well as the tons of hot strip produced in the mill in the period of 1953 to 1956 inclusive. If the hot strip tonnage and the respective operating hours for 1953 are assumed to be 100 per cent the performance of the mill may be illustrated graphically as shown in Figure 3. The efficiency of the mill was increasing steadily and has shown a particularly substantial increment during the last year. It is proposed to briefly analyze the causes for such a substantial growth. The strip rolling will be considered only.

The monthly average tons per hour for strip rolling is shown on Figure 4. Familiarization with, and understanding of, the equipment by the personnel, systematic maintenance, understanding and improvements in the technological processes and co-operation of the crews with supervision were the starting points for the increase in efficiency.

When the whole mill train was considered, it was found that the continuous 56-in. train was rolling generally faster than the roughing mill, this situation being particularly accentuated with increasing finishing gages. Only with 18 and 16 gage, the continuous train rolled slower than the rougher and became the bottleneck in the mill operations. The first objective, therefore, was to decrease the rolling time in the roughing stand and bring its capacity closer to the capacity of the 56-in. train and to a balance between those two basic elements of the equipment. After studying the loads

Figure 2 — Chart gives total annual production of plate and strip and total annual production of strip off the 56-in. hot strip mill.

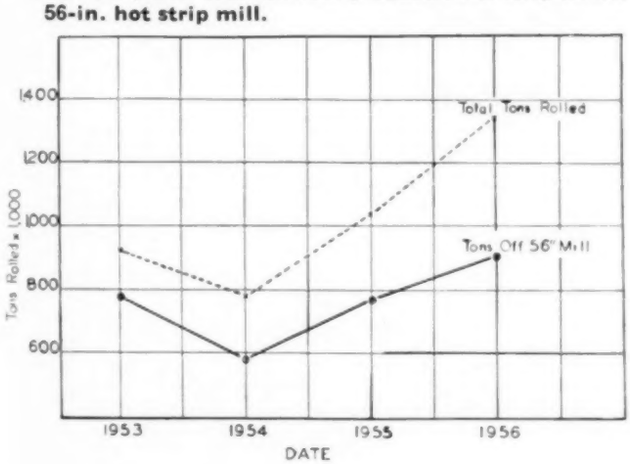
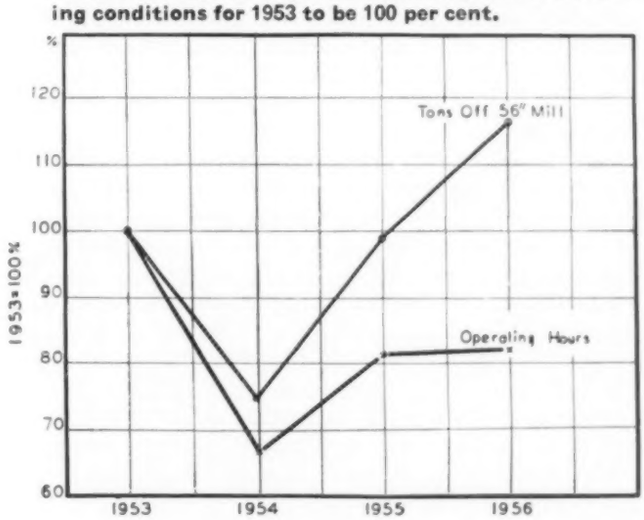


Figure 3 — Annual performance of the 56-in. hot strip mill is indicated by tonnage and operating hours, assuming conditions for 1953 to be 100 per cent.



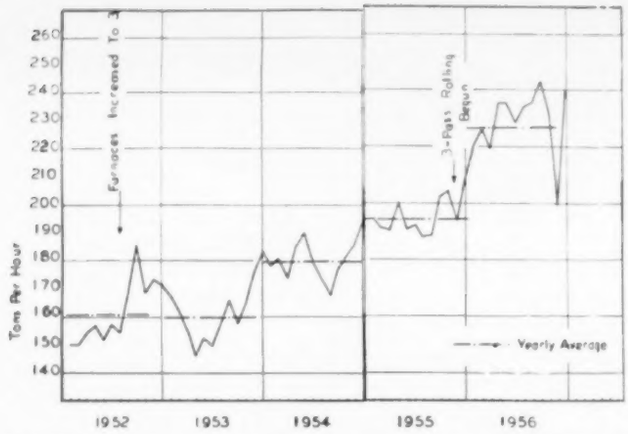


Figure 4 — The monthly average tons per hour for the past five years are indicative of a great increase in operating efficiency.

imposed by the stand on the mill motor for different slab widths and thicknesses by various drafts and corresponding mill speeds, it was found possible to apply a 3-pass rather than a 5-pass breakdown for slabs of up to 42 in. wide and $4\frac{3}{4}$ in. thick rolled down to a bar approximately 0.8 in. thick. This practice was not conducive to any peak loads, ensured a more uniform and full load of the mill motor, and resulted in a substantial decrease in the rolling time in the roughing stand. This, in its turn, eliminated the bottleneck created by the rougher for an additional gage range, brought the two elements of the equipment closer to a physical balance, and resulted in a general substantial increase in tons per hour (Figure 4).

Since the data on Figure 4 represents overall averages for the mill irrespective of rolling practices, a comparison between 3-pass and 5-pass breakdowns is made in Figure 5. Here the potential possibilities of a reversing single stand roughing equipment, even with an independent edger (not close coupled to the rougher) are clearly to be seen. Though rolling using 5-pass schedules has again shown an increase in efficiency (approximately 5 per cent) as compared with the previous year (1955), the application of 3-pass schedules resulted in an increase in the production rate of about 30 per cent. The frequency of the application of 3-pass schedules during daily operations since their introduction is shown in Figure 6. The temporary decrease in the production rate in December, 1956, is explained by mechanical troubles (breakage of spindles). The variety of gages and widths that have been rolled during the same period of time may be illustrated by the monthly number of gage and width changes (Figure 7) and by the tons per gage and width change (Figure 8). This indicates that the increased efficiency of the mill was not caused by any favorable programming of gages or widths, but by improved operating methods.

The steady increase in the production rate of the mill imposed heavier requirements on the slab reheating furnaces and today they are loaded above their rated capacity. However, nothing has been sacrificed from the point of view of slab quality or furnace efficiency. The formation of a desirable, loosely adhering scale is controlled by the furnace atmosphere, the furnace temperature and the time at temperature. All those factors were investigated on operating furnaces and a proper bal-

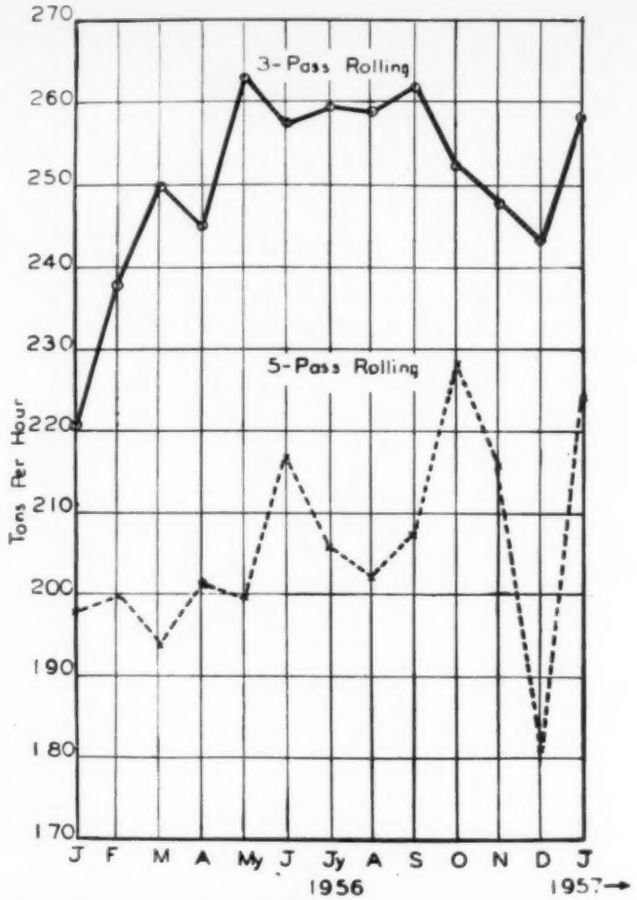
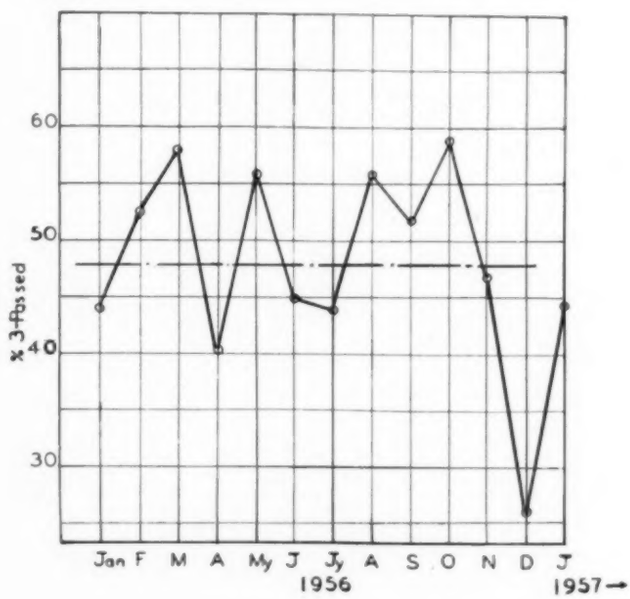


Figure 5 — Chart gives monthly average tons per hour for three-pass and five-pass rolling practices during 1956.

ance between them and the mill production rate established. The furnace atmosphere is checked periodically and maintained consistently oxidizing. The maximum possible fuel oil input has been raised from 600 to 1000 gphr per furnace which increased the flexibility of the furnaces and their adaptability to high and varying

Figure 6 — Chart gives monthly percentage of material to which a three-pass breakdown was applied during 1956.



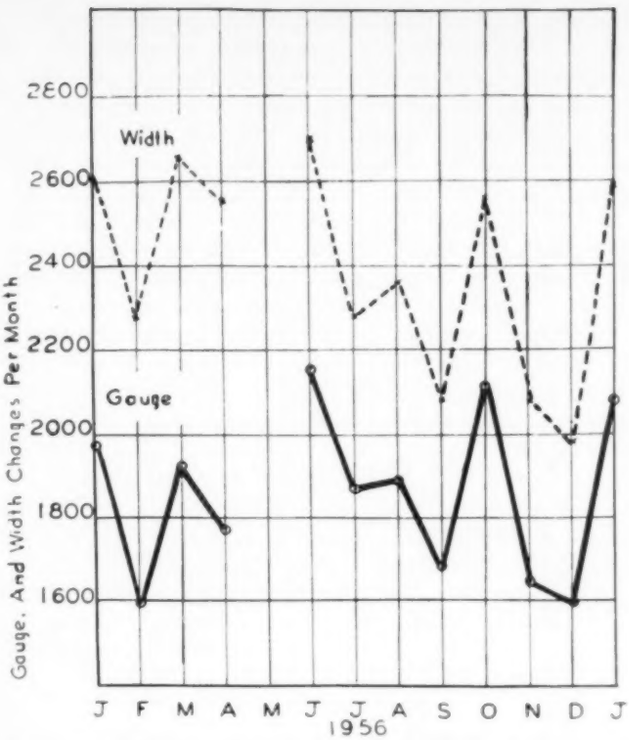


Figure 7 — The number of gage and width changes per month is indicative of the wide variety of material rolled in the 56-in. hot strip mill.

production rates. The furnace temperature is maintained generally around 2300 to 2350 F, but may be raised when the production rate of the mill increases (shorter furnace times) and cut back with a decreasing demand by the mills (longer furnace times). Thus, a desirable balance between furnace time and temperature is the aim of the operators. As a result of these measures, the frequency of rolled-in scale has decreased during the last two years in spite of a substantially higher production rate. The furnace efficiency may be illustrated by Figure 9. The Btu per ton figures were steadily decreasing with an increasing production rate (Figure 4) up to and including 1955. The fact that they did not show a further decrease in 1956 in spite of a substantial increase in the production rate may indicate that they are now loaded (up to 100 tons per hour per furnace for certain runs) beyond the limit of their optimum efficiency and rated capacity.

As the rolling time in the 110-in. roughing stand was decreased, it became possible to increase the finishing speed of the 56-in. continuous train without upsetting the balance between the mills. Both these factors tended to increase the finishing temperature for a given gage. The control and maintaining of metallurgically desirable finishing temperatures (somewhat above A_3) was facilitated and the temperature differential between head and tail narrowed down. The average variation in gage from head to tail in a coil is now about 0.003 to 0.004 in., only the outermost one to two wraps of a coil will show an additional 0.003 in. increase in thickness.

This made it possible to gradually increase the weight of the slabs rolled without interfering with metallurgical temperature requirements (Figure 10). This also was a factor which had a favorable effect on the production rate of both the hot strip and cold reducing processes.

The total sprayed length on the runout table is at present 132 ft-4 in. Since it is felt that for strand annealed strip the coiling temperature should be reasonably low (about 1050 F) and an increase in the production rate tended to increase the finishing temperature, an addition of further sprays, which would increase the sprayed length of the runout table by approximately 68 ft is now being considered. This measure would make the control of coiling temperatures more flexible and give room for eventual speeding-up of the mill.

Figures for total mill delays for the period of time of 1953 to 1956 are shown in Figure 11. These delays include all interruptions in the process due to mechanical and electrical reasons, roll, gage and width changes, cobbles, etc. Since the rolls, both on roughing and continuous train, are changed for redressing every 24 hr (after every strip rolling period of one to two turns, giving an operating time of 8 to 16 hr per day), the delays for roll changes which are part of the values of Figure 11,

Figure 8 — The tons rolled per gage and width change are a further indication of the diversified product split off the mill.

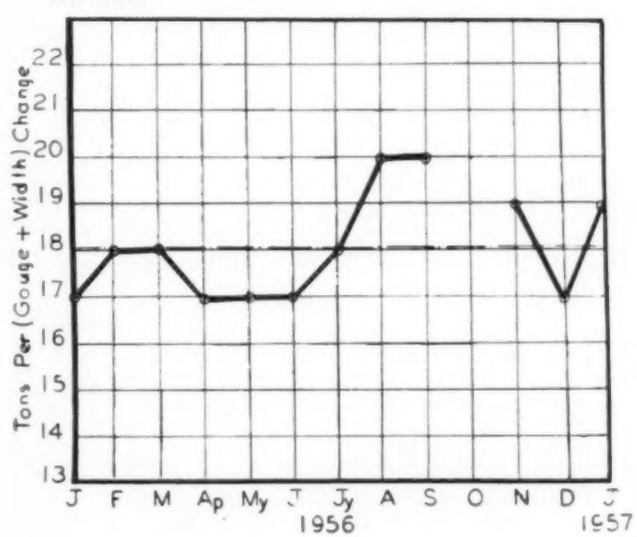
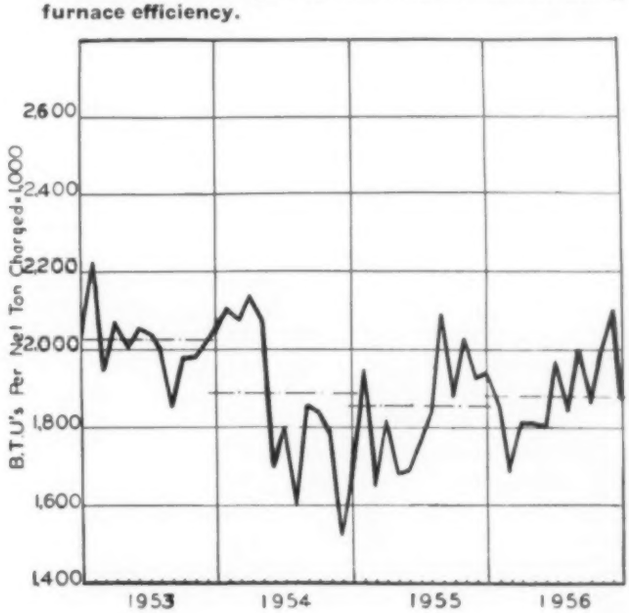


Figure 9 — The Btu per net ton charged show a decreasing trend and can be regarded as a measure of increasing furnace efficiency.



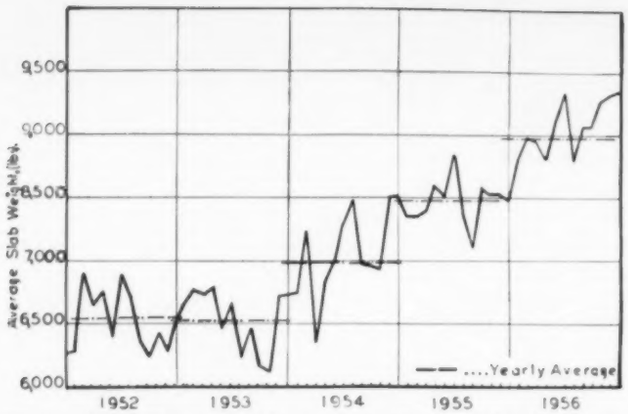


Figure 10 — The monthly average slab weight has been steadily increasing over the last four years, almost in parallel with the increase in tons per hour.

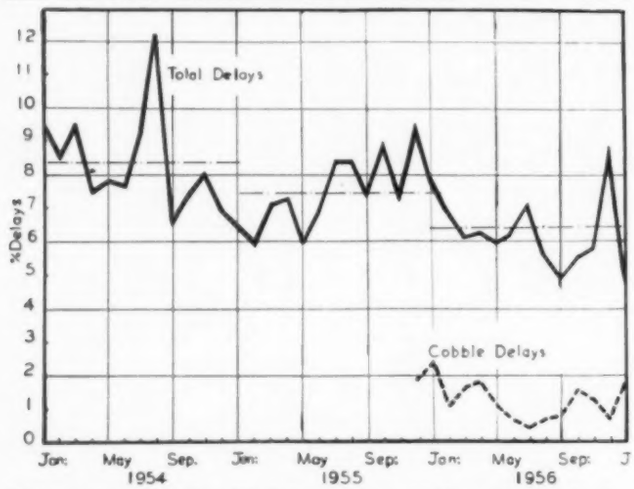


Figure 11 — Total mill delays per month and cobble delays, both in the mill and coilers, are gradually decreasing, indicating increased efficiency of the operating crews.

are only those which occurred during a strip rolling period. As they may not be used for comparison with mills having a different schedule of roll changes, they were not shown separately on the graph. The actual roll life (work rolls) in tons of steel rolled per year is shown in Table III.

TABLE III

	Life of work rolls in tons of steel rolled			
	1953	1954	1955	1956
110-In. reversing mill	57870	59968	69339	80529
56-In. continuous train	116210	108126	101543	108579

As the figures in Table III indicate, the application of more efficient 3-pass rolling schedules have resulted in an increase in roll life.

Of some interest may be delays caused by cobbles of all types (Figure 11). Both the total delays and the delays due to cobbles are indicative of a trend of steady improvement in the maintenance and operation practices and show a very satisfactory present standard of operations. The figures of delays of approximately 7.5 per cent in 1955 and 5 per cent in early 1957 on an operating base of 344 hr per month, gave to the mill the equivalent of 8.5 operating hr per month or, at 240 tons per hr over 2000 tons of product. It is most important to every operator to have analyzed independently all delays for the purpose of preventing recurrence. It is felt that of considerable importance in this matter were the educational programs, instituted by supervision for the operating personnel and the co-operation of the crews with the supervision. One of the aspects of the educational program is the rotation of supervisors from one section of the mill to another with the purpose of familiarization with the requirements, difficulties and peculiarities of different stages of production.

The inspection of the slabs in the slab yard has been investigated from the point of view of surface defects which may result in surface quality rejects after rolling. Resulting reasonable inspection practices had a favorable effect on the per cent diversions and scrapping of slabs in the slab yard (Figure 12). Adequate open hearth and blooming mill practices were, naturally, of great assistance in obtaining the very low rejection figures without lowering the quality standards.

There is every reason to believe that a further im-

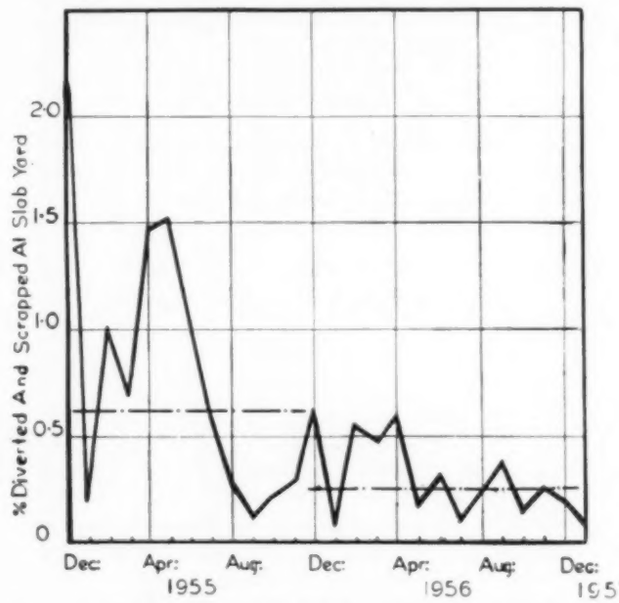
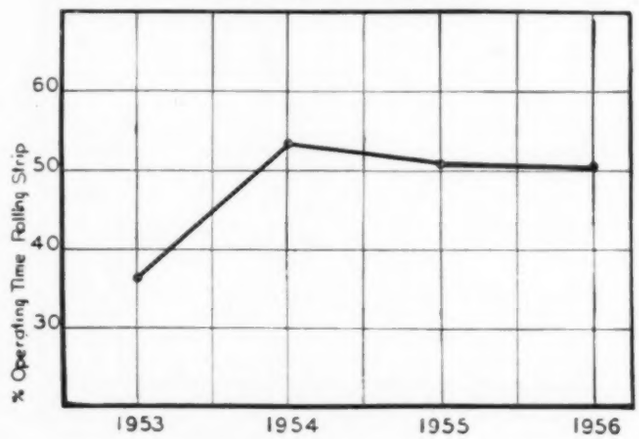


Figure 12 — Percentage of slabs diverted or scrapped at the slab yard show a large decrease, indicative of improved practices both in the open hearth and blooming mill.

Figure 13 — Percentage of operating time in which strip was rolled has not increased over the past three years, yet production and tons per hour have risen by nearly 50 per cent without capital investment.



provement in the production rate and of operational standards can be achieved. The substantial improvement in the production rate of the mill in 1953 to 1956 was obtained without any substantial capital investment during the last 4½ years.

An average increase in production rate of 46 per cent (1953 as compared with 1956) was achieved on the same equipment without capital investment. The production rate was increased by 30 per cent (1954 as compared with 1956) without affecting the mill time available for rolling plate (Figure 13). Thus, a substantial increase in efficiency is possible on available conventional equipment and, if obtained, will expand the possibilities of the mill without further investment.

DISCUSSION

PRESENTED BY

A. L. ROBERTS, Assistant Superintendent Sheet, Tin & Strip Mills, Bethlehem Steel Co., Sparrows Point, Md.

HOWARD S. ORR, Project Development Engineer, Rolling Mills, United States Steel Corp., Pittsburgh, Pa.

R. J. BARRY, Superintendent, Plate and Strip Mill, The Steel Company of Canada, Ltd., Hamilton, Ontario, Canada

A. L. Roberts: There are a number of ideas presented which are very interesting. Most mills of a particular type must operate on the same basic principles, but in addition each one does some details differently. It is those things which we watch for mostly. The performance of this mill must be rated as excellent. It has improved steadily to the point beyond which they cannot easily go much further, because they are operating at top level speeds with a very small average interval between slabs. They simply must get the results they do. They have analyzed the equipment and its possibilities and then have planned and engineered ingeniously to get maximum production.

A good example of this is the way they arrived at the scheme for three-passing through the rougher as much as possible. That serves to occupy the finishing train with work a maximum part of the time. That is, it has allowed them to operate with the minimum possible average in the interval between slabs. Also, they have increased the average slab size and have realized a large increase from that. In fact, their increase in production has almost paralleled the increase in slab size.

We have all experienced some such relationship but this one demonstrates the point very clearly. The delay time is remarkably low, and must represent the efforts of very co-operative personnel. The whole result is about as much production as can be imagined.

There are a number of points that were particularly interesting to me and I hope that Mr. Barry might choose to tell us some more about them. In the first place, I was interested in knowing whether he had ever considered a need for higher descaling water pressures.

The second concerns their heating. He has indicated that they have a very fine scale and that they have been able to keep the quality of the heating up as their tons per hour and the production of the mill, have come up. He has stated, that it is quite easy but we have not found it so. It is a difficult thing to do and I would be very much interested in knowing if he can tell us more about how they get that fine type of scale that is desirable, and also how they keep the slabs hot. That is, how they keep them at the heating temperature in the furnace at the high rolling rates as long as they do at the lower rolling rates.

Also, there is one other point I think many of us would be interested in, if he could tell us some more about this procedure that they have for the rotation of supervision.

Howard S. Orr: I want to ask our friend from the North if he could tell us a little bit of any differences he observed in surface, yield, finishing temperatures, or run down when he changed from five-pass to a three-pass schedule on the rougher.

For cold mill breakdowns, what is the thickest slab he uses when roughing on a three-pass schedule?

R. J. Barry: In reply to Mr. Roberts' question on descaling pressures, we naturally would appreciate having such an improvement. However, there are, in our estimation, needs in our department for expenditures which would return greater savings. To enlarge on our descaling procedure, we have three separate units of top and bottom sprays at our breakdown mill, as well as top and bottom sprays at the entry to the 56-in. mill. In addition there are steam jets at the breakdown mill and 56-in. train.

The desirable condition of fine scale is mainly the result of proper control of furnace atmosphere and temperature. This is the responsibility of the heaters, as is the proper heating of slabs at increased rolling speeds. They have control of heating and soaking zone temperatures which can be increased to allow for drawing slabs at a rate of 100 tons per hr per furnace, with slab temperatures within required ranges. The co-operation and guidance of our combustion engineering department is another important factor in the control of scale and slab drawing speed.

The rotation of supervision is a practice that we have been using for the last ten years. As our company expanded we felt the need of better trained supervisors, and, as you are well aware, the problems of supervision today in respect to industrial relations does not make the job as attractive as formerly. So by carrying a few extra supervisors and placing them in different locations in our mill for periods of around six months, as conditions allowed, along with vacation schedules, we have made it possible for our supervisors to have a greater understanding of the problems of over-all operations. When I was in the bloomer, we used the same system there and by taking a mixture of young college graduates and mill boys and giving them this additional training, we ended up with efficient supervisors.

In answer to Mr. Orr's remarks, or questions, on the gage rundown between three and five-pass, I would say there is very little difference. The big advantage of the three-pass operation is on lighter gages since we are able to meet metallurgical requirements for finishing temperatures along with increased production, assisted by heavier slabs.

On the breakdown of three-pass material we reduce from 4½ in. for cold mill material, and have gone as high as 4¾ in. on widths up to 42 in.

New Ore Handling, Screening and Sintering

"ENGINEERING AND MECHANICAL FEATURES"

By MELVIN BECKER
Engineer
Engineering Department
Bethlehem Steel Company
Sparrows Point, Md.

▲ THE new ore handling system was designed to receive ore from ocean-going ships using one to five unloaders simultaneously, and to transport it to a new storage field located approximately one mile away; also to reclaim ore from the new field and deliver it back through part of the system to either of two sets of overhead storage bins, one set of bins receiving ore for sinter plant use and the other set of bins storing ore for use in the blast furnaces. In addition, this system is capable of receiving ore from the unloaders and transporting it directly to the bins, and at the same time reclaiming ore from the new storage field. The system was designed for the following capacities, based on 200 lb per cu ft material:

Stocking out—6200 tons per hr.
Reclaiming—1250 tons per hr with one bridge.
Reclaiming—2500 tons per hr with an additional future bridge.

The system consists of the following equipment (Figure 1):

1. Approximately one mile of 60-in. wide conveyor belt.
2. 900 ft of 48-in. wide conveyor belt.
3. Five hoppers with feeders mounted on three existing bridges and two existing unloaders at the main ore field.
4. A new auxiliary ore field of about 1,500,000 net ton ore capacity.
5. A new 350 ft span bridge with a 125 ft cantilever at each end.
6. A 71-ft boom stacker.
7. A reclaim hopper.
8. A new ore screening station, complete with approximately 9000 net tons of bin storage and feeders and shuttles to feed run-of-mine ore to any four of five 6 x 16 ft double deck gyratory screens at one time.
9. Stock bins to store unscreened ore or limestone from the ore handling belt system or to hold ore and sinter from the sintering plant conveyor system.

The growth of ore requirements in the Sparrows Point plant and the changes, brought about by new ore sources, increased the ore inventory requirements in the blast furnace area in excess of the available storage area. The former manner of handling excess ore inventories from the existing unloading dock by truck to an area where the auxiliary ore field now is located and returning this ore in a similar manner to the existing ore field presented a case for justifying a more efficient ore handling system. Also, inability to feed the existing screening station with the existing trestle system beyond a three sintering strand capacity required a change in ore handling to feed sufficient ore to the screening station for six sintering strands, four of which are now operating and two are under construction.

The old storage field is bounded by a trestle on the north side containing the blast furnace stock bins, and a trestle on the south side on which transfer cars are loaded with ore by the bridges for transfer to the blast furnace stock bins or to the old screening station bins which were incorporated in the trestle system as shown in Figure 1. It is easy to visualize the traffic problem that results from feeding an excessive amount of ore to the old screen bins and the reasons, therefore, for providing alternations to the ore handling system and screening building setup.

There are eight modes of operation for the ore handling system, each of which will be covered (Figures 2 and 3).

Mode A—Stocking out—Ore is unloaded, by bridges or unloaders, from the ore ships and fed, by means of feeders, at a controlled rate on to C1 conveyor. From C1 conveyor, the material feeds on to the north-south reversible conveyor, C2. Next the ore feeds on to reversible conveyor C3 located along the length of the auxiliary ore field. The stacker, which can rotate 180 degrees, can feed material into a windrow on both the north and south side of C3 conveyor. From this win-

. . . . ore handling system at Sparrows Point was based to a certain degree on the unit at Lackawanna . . . . Sparrows Point system, however, has many more modes of operation and handles different ores . . . . variable voltage was used in the bridge drives . . . .

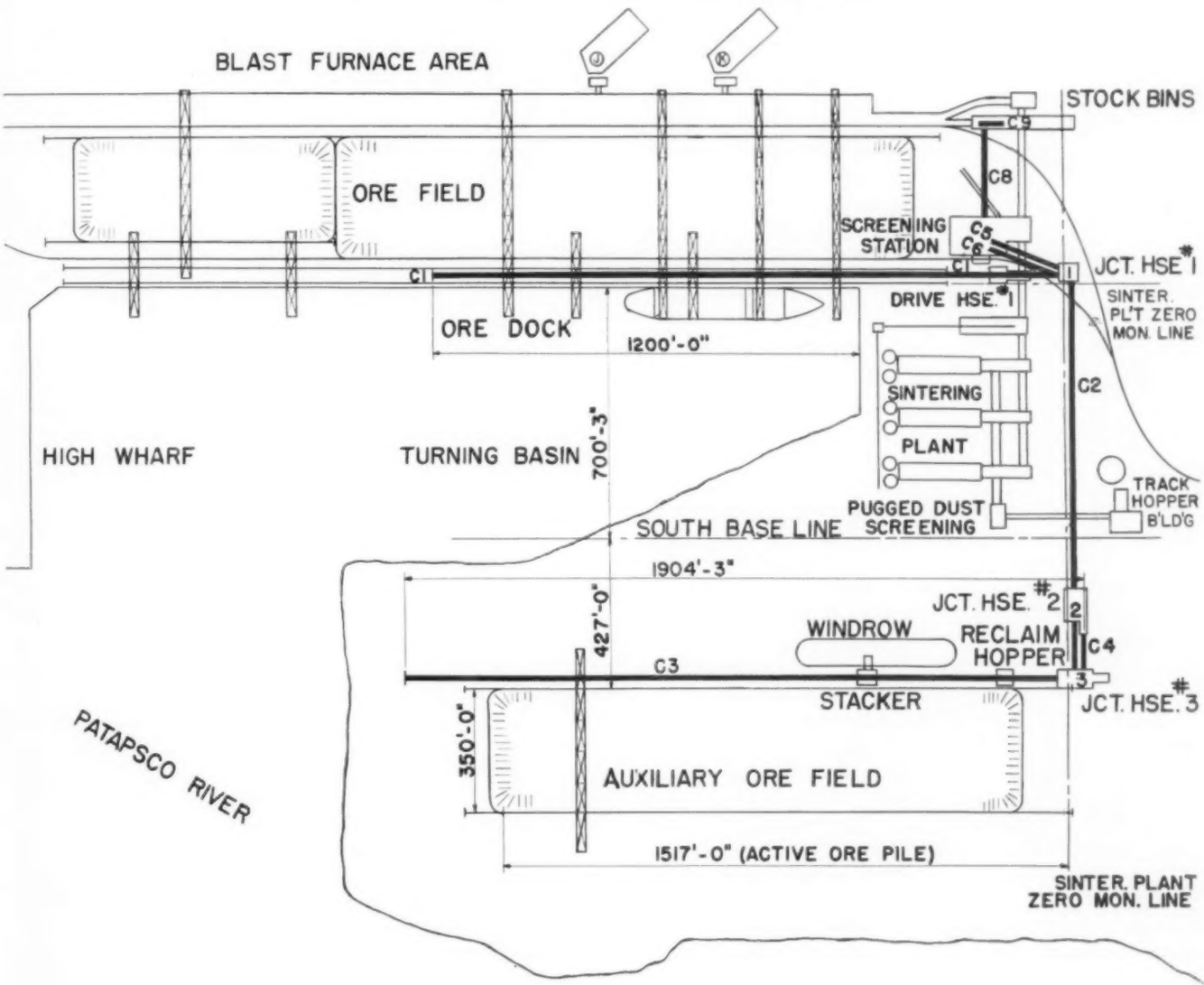
Facilities at Sparrows Point

drow, the auxiliary ore bridge can cast the ore back into storage.

Mode B—Unloading to screen storage bins—This is similar to mode A, ore is fed on to conveyor C1 and then on to conveyor C5 running to the top of ore screening station. Reversible shuttle, C5A conveyor takes the material from C5 and transfers it to one of two reversible shuttles, namely, C7A or C7B, which in turn feed into one of six screen bins.

Mode C—Reclaiming to screen storage bins—The auxiliary ore field bridge reclaims ore from the auxiliary ore field, at the rate of 1000 net tons per hour, into the reclaim hopper, which in turn feeds on to C3 conveyor. From C3 conveyor, ore is transferred to C4 and back on

Figure 1 — Layout of ore handling system and ore dock.



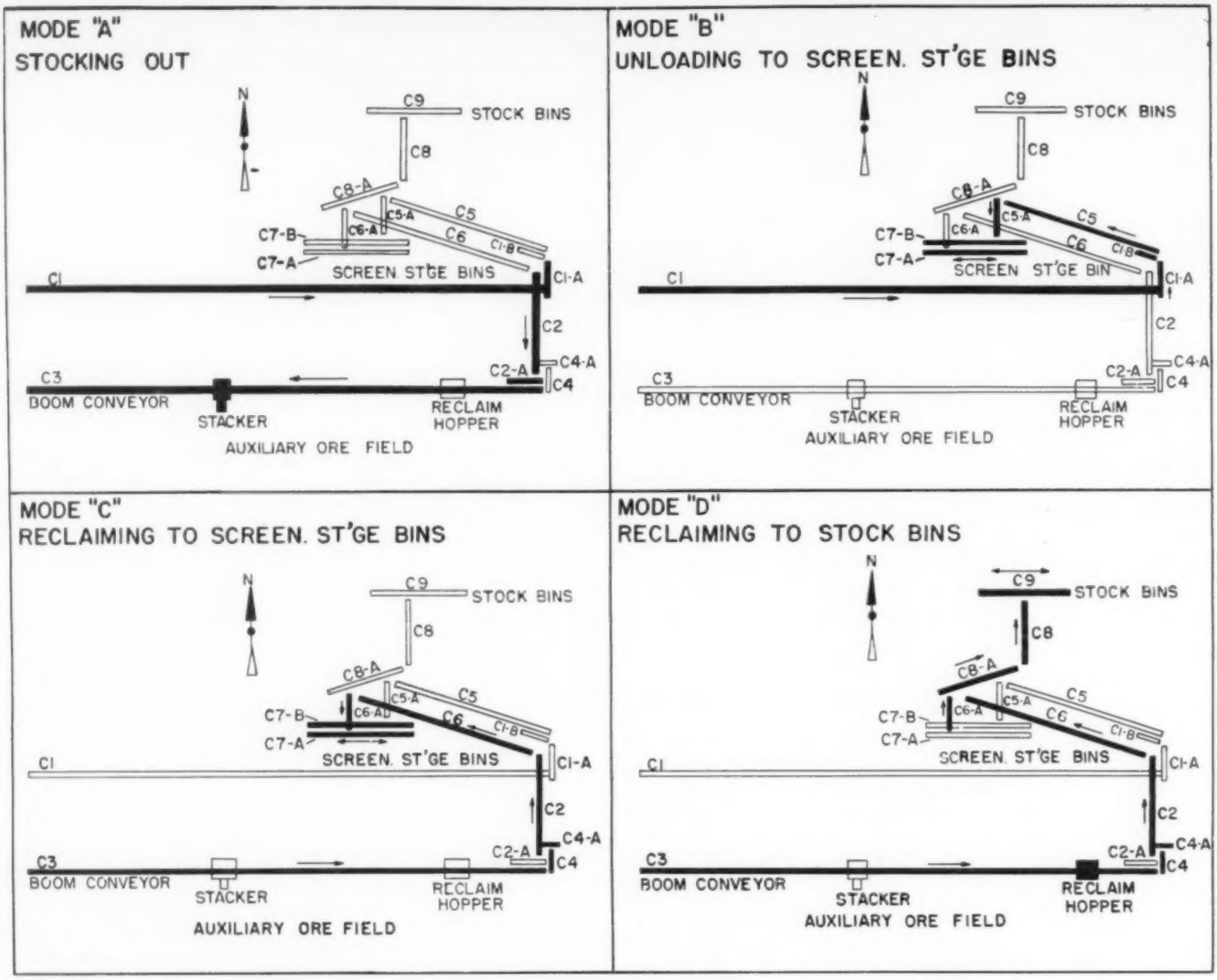


Figure 2 — Four modes of operation are shown in these sketches: stocking out; unloading to screening storage bins; reclaiming to screening storage bins; and reclaiming to stock bins.

to C2 conveyor which is running in a northerly direction. From C2, ore deposits directly on to C6 conveyor and then is transferred by shuttle conveyors to the screen bins.

Mode D—Reclaiming to stock bins—Ore is reclaimed from the auxiliary ore field to conveyor C6 in a similar manner to that described for mode C and then on to conveyor C8, which in turn transfers the material to the reversible shuttle conveyor C9 which can feed into any one of five stock bins. It should be noted that this mode is designed to reclaim materials from the auxiliary ore field, such as limestone or other miscellaneous ores, which are not screened.

Mode E—Unloading to the stock bins—The system is also designed to convey ore, or other miscellaneous materials, direct from the main ore field to the stock bins. It should be noted that since conveyor C1 is a 60 in. wide belt and conveyors C8 and C9 are only 48-in. wide belts, the unloading on to C1 conveyor has to be limited to 2500 net tons per hour when using this mode of operation.

Mode F—Combined duty—combination of modes D and B—unloading to screen storage bins and at the same time reclaiming to stock bins—A glance back at the descriptions of these two modes will indicate that there is no conflict in operation. Basically, the additional flexibility and ore handling capacity of the belt system for combined duty operation was achieved by providing a double belt system, conveyors C5 and C6, from junction house No. 1 to the screening station.

Mode G—Combined duty—combination of modes C and E—reclaiming to screen storage bins and at the same time unloading to stock bins—Here again, referring back to the respective modes of operation C and E, it is apparent that this combined duty can be regularly accomplished. Once again the additional flexibility was accomplished in the same method noted under mode F.

Mode H—Combined Duty—combination of modes B and C—unloading to screen storage bins and at the same time reclaiming to the screen storage bins—This is similar to mode F the double belt system, conveyors C5 and C6 makes this operation possible.

Of considerable interest are the many design problems encountered in engineering the ore handling system and sintering plants. Of course, characteristics of terrain, basic to all conveyor systems, including interferences with existing installation, determined to a large extent the actual layout. Certain bases of design were

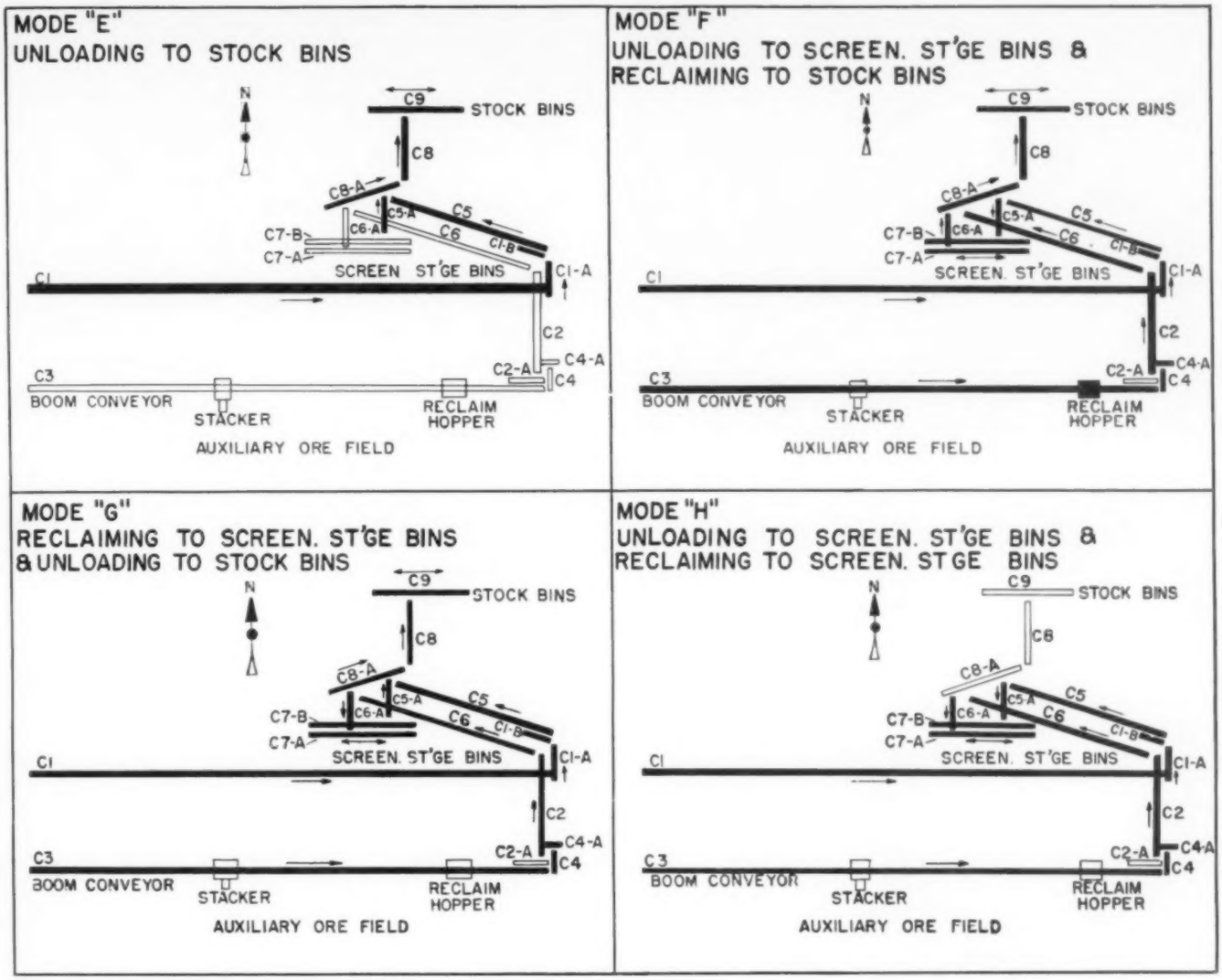


Figure 3 — Four modes of operation are shown in these sketches: unloading to stock bins; unloading to screening storage bins and reclaiming to stock bins; reclaiming to screen storage bins and unloading to stock bins; and unloading to screening storage bins and reclaiming to screening storage bins.

used as a guide in the layout, namely that the maximum slope of any of the belt conveying systems would be limited to 12 degrees, if possible; that transfer on the 60-in. belt system (where the amount of material being handled is 6200 net tons) would be accomplished by use of an intermediate short belt. For instance, conveyor C1 discharges on to conveyor C2 after first discharging on to C1A, and C2, in turn, discharges on to conveyor C3 by the use of the intermediate conveyor C2A. The usage of the short conveyor belts C2A, C1A and others was intended to reduce wear and tear on the main conveyors when changing direction and/or speeding up the transferred ore in the new direction from 0 to approximately 500 fpm. On the other hand, where consideration was given to handling ore at the maximum reclaim rate of 2500 net tons per hour, ore is generally discharged direct from one conveyor to another at the transfer points without the use of the short belts. Of course, there was an attempt to hold transfer points to a minimum and interference with existing operations was held to a minimum; therefore, from the standpoint of general layout, after first reviewing grades and elevations, let us follow through the various conveyors to determine why and how they were located, both as to plan and elevation.

Referring to Figure 1, and considering the grades and elevations above sea level that prevail in the area, the following is pertinent:

Elevations of the tracks along the existing ore dock are approximately +12 ft 10 in.

Elevations of the area around the sintering plants are, generally, from +12 to +14 ft.

From a point just north of junction house No. 2 the elevation rises sharply to about +30 ft.

The elevation at the auxiliary ore field is +20 ft and the stacker tracks are +26 ft 6 in.

The trestle system surrounding the existing ore field is approximately at +30 ft elevation.

The tracks running north and south beneath both trestles near the junction point are slag tracks and had to be maintained in service during construction, and a design had to be adopted to maintain their usefulness.

C1 runs 1200 ft along the dock face which is a sufficient distance to accommodate two large ore carriers, which in turn can be emptied by the bridges and unloaders directly on to the belt. C1 conveyor had to pass

Figure 4 — Conveyor C-1 runs 1200 ft along dock face.

Figure 5 — View shows dock face looking west.

Figure 6 — C-1 conveyor gallery runs from No. 1 drive hoist to pass between two sintering plant galleries and over the other trestle.

over the trestle system and under the sinter conveyor from the sintering plant. These limitations of clearance, both above the trestle and underneath the sinter conveyor, determining the maximum radius of curvature for Cl conveyor. These points are illustrated in Figures 4, 5 and 6.

Conveyor C2, which runs north and south from junction house No. 1 through junction house No. 2 to junction house No. 3, presented no unusual problems except for those of track clearance, interference with electric utilities, etc.

Conveyor C3 (Figure 7) running east and west on the north side of the auxiliary ore field, is a straightforward design and again presented no unusual problems; it should be noted, however, that the elevation of conveyor C3 and in turn of conveyor C2 at junction house No. 3 were established in a manner such that when conveyor C3 was driven to the east, water on the conveyor belt would pass into the junction house and drain, by gravity, through a culvert into the lower elevation of the auxiliary ore field.

Conveyor C4 presented no unusual engineering problems.

The conveyors and discharging points at junction house No. 1 presented problems of head room between various floors because of the intermediate short transfer belts and multiple transfer points required.

The conveyor arrangement in the screening station is unique and the installation will be covered in detail a little later in the paper.

Conveyor C8, as previously stated, was installed to transport any ore, or miscellaneous material that was not to be screened, direct to the stock bins over the north trestle. Except to locate the spots to clear lump ore obstructions within the ore field, this conveyor presented no unusual problems. Shuttle conveyor C9, within the stock bin building itself, was designed to feed up to five stock bins from conveyor C8.

The previous description is, of course, general but

Figure 7 — Conveyor C-3 runs east and west on the north side of the auxiliary ore field.

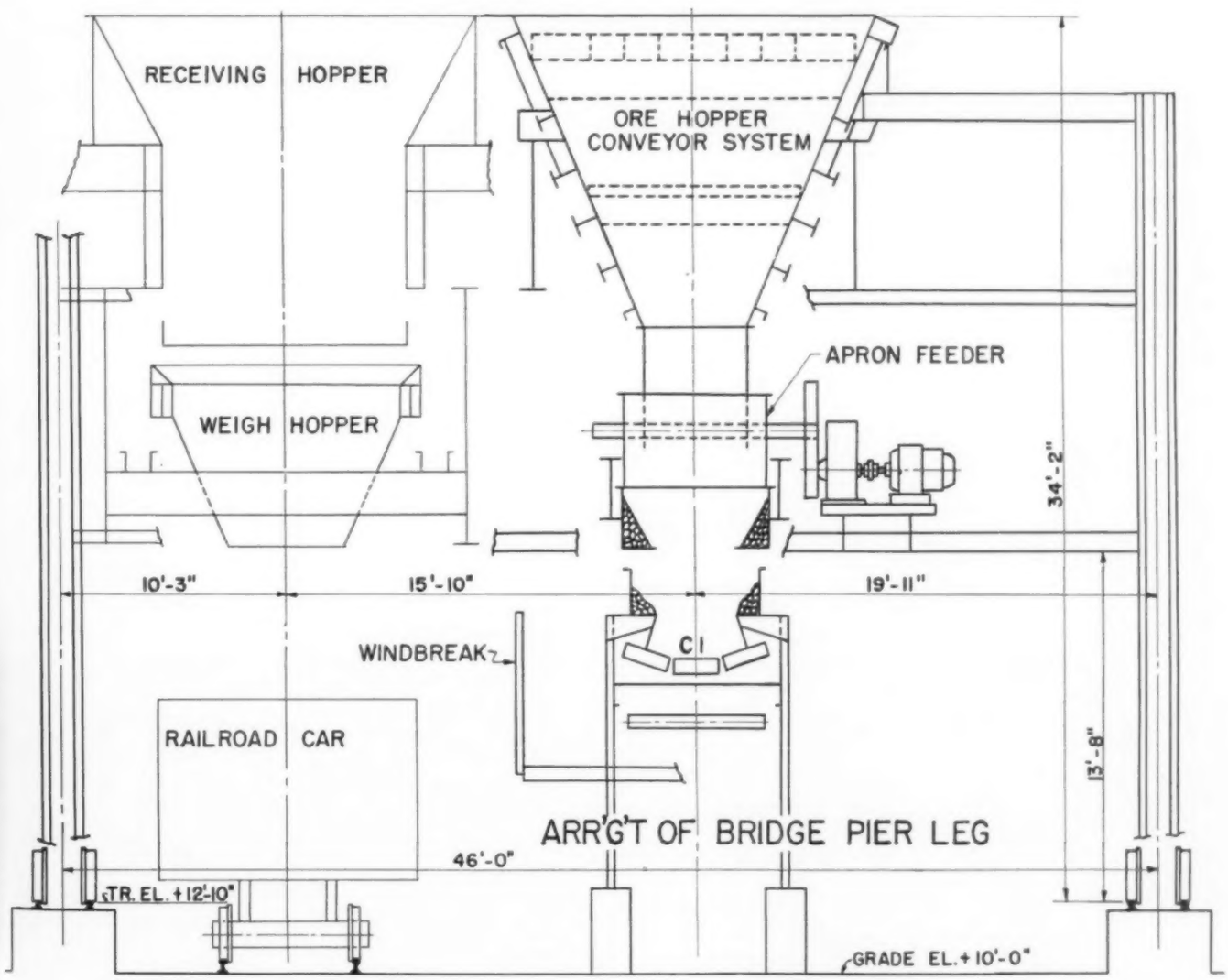
should give a basic understanding of the general design problems encountered in the engineering of the ore handling and sintering plant systems. Many detailed problems arose during the course of the engineering and construction of these systems. A few of the most important of these problems and how they were resolved will be discussed.

The conversion of the existing bridges and unloaders was one of the biggest engineering problems encountered in the whole system (Figure 8). To better illustrate and to understand specifically what the problem was, and how it was resolved, let us review briefly the operations performed by the units and the equipment which they contained to do the job. Bridges, as used at Sparrows Point, are capable of unloading from the ships, loading directly into trestle cars or in the trough, and in turn casting back the ore from the trough to the field and reloading cars on the trestle. In addition, the bridges have receiving hoppers and traversing weigh hoppers equipped with gates or feeders which can load railroad cars (out-bound shipments) with ores and other miscellaneous materials. The ore handling system required a receiving hopper with a feeder to load ore, at a controlled rate, on to C1 conveyor. The installation of this hopper restricted, by necessity, the ability to traverse the existing weigh hopper that was used to load railroad cars; therefore, the final installation was designed to contain a receiving hopper and fixed weigh hopper for loading cars on the southernmost track and a receiving hopper and feeder for feeding the ore handling system. The resultant installation nearly doubled the load which was imposed on the pier leg structure, and, of course, the truck wheels. As a result, many alterations were required in the pier leg structure to carry a load for which the original bridges were not designed.

The unloaders were not used to load railroad cars, and therefore, contain no receiving hoppers. As a result, it was comparatively simple to install a hopper and feeder for the belt system in the unloaders, although the same factors of structure, bearing and wheel loadings, had to be considered and some modifications were made.

A second problem which concerns both the design of C1 conveyor and also the hopper construction feeding the belts can best be understood by referring to Figure 9 showing track dimension along the dock face which existed at the time of the conveyor installation. It can

Figure 8 — Conversion of existing bridges was one of the most difficult jobs to be accomplished.

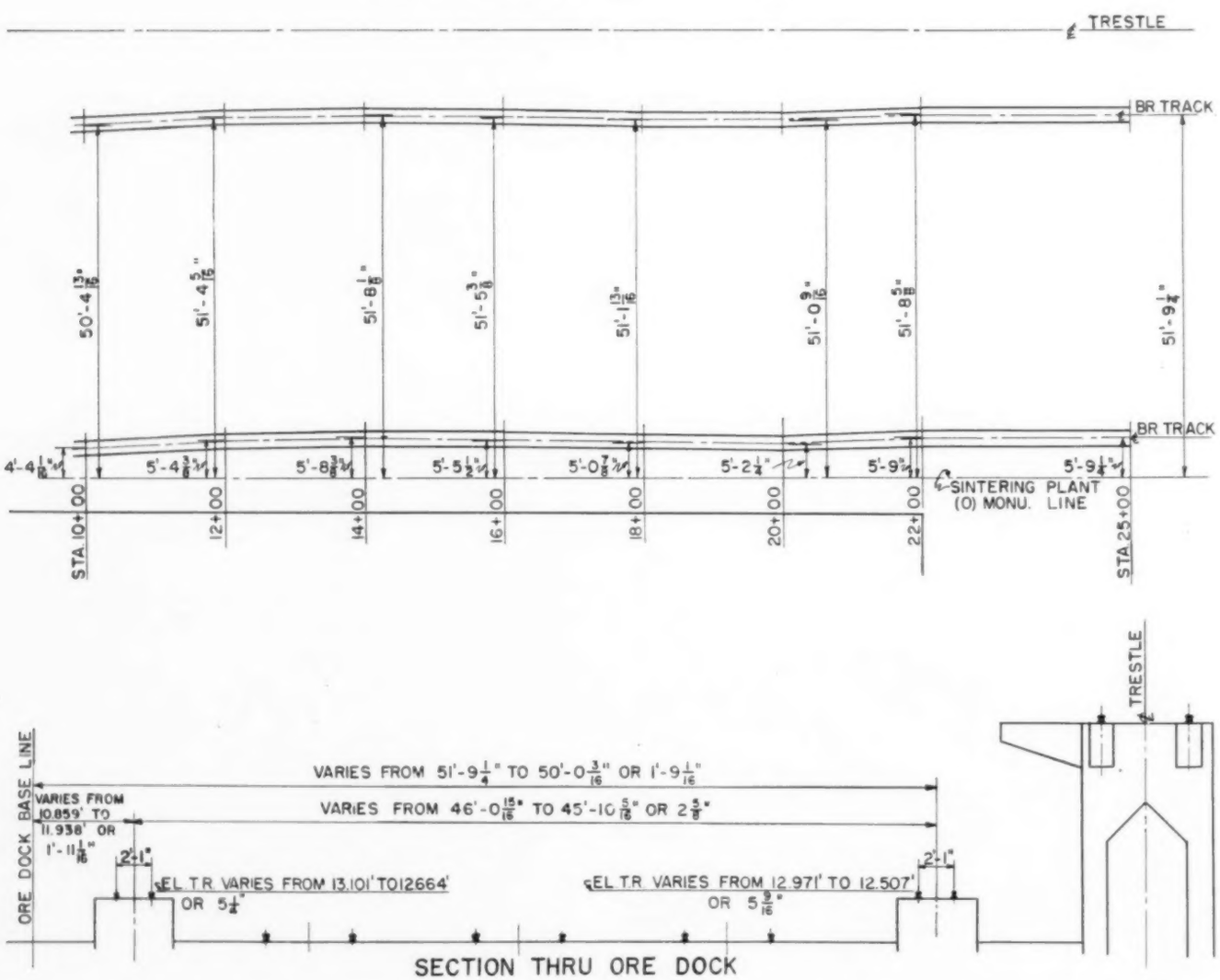


be noted that the load of the existing ore field has resulted in some displacement of the dock face, railroad track and bridge track runways. As a result, the bridge position varies somewhat, relative to an east-west axis as the bridge units move back and forth along the ore dock; therefore, the feeder, which is mounted on the bridge, will also move somewhat in a north-south direction as the bridge moved down the ore dock. Therefore, some method had to be devised for feeding the conveyor belt, which runs east and west on a straight line, by a feeder that would traverse north and south of the centerline of the belt. The issue was resolved in two ways: C1 conveyor was put at a slight angle to the ore dock base line in an attempt to average the movement of the bridge feeders on the north and south side of the belt. Secondly, continuous skirts were placed the full length of the belt along the ore dock and a specially designed feeding chute was placed below the feeder as shown in Figure 8. Note that although a movement of the bridge, relative to the belt line, will cause some off-center loading; nevertheless, a minimum of spillage should result and the situation is certainly improved over what would be expected if such a provision had not been made.

The vital part of the whole ore handling system was, of course, the location and size of the auxiliary ore field. To better understand how the location was determined, including elevations, review the terrain condition as it previously existed. This part of the Sparrows Point plant was used as a slag disposal area, and over the years, the general elevation in the area, as the land had expanded to the south, was in the neighborhood of 40 to 45 ft. Superimposed above the layer of slag were various deposits of ore which had been trucked out to the area for storage. Beneath the layer of slag there was a typical combination of silt, sand and clay (Figure 10).

First, based on fill requirements for other construction projects currently being installed at the Sparrows Point plant, it was determined that we would establish the grade of the auxiliary ore field at elevation +20 ft and the bridge runways at elevation +26 ft 6 in. Secondly, based on the anticipated soil loading from the intended ore storage, it was calculated that a minimum of 350 ft from the bridge runways to the shore line would be required if we were to avoid forcing mud and silt out into the ship channels. Third, based on a preliminary analysis of bridge span versus cost and operating flexibility, along with considerations of obtaining total storage capacity desired, it was determined to use a 350 ft span bridge. Furthermore, on the basis of

Figure 9 — Plan and elevation of ore bridge track.



utilizing areas to the north and south of the field runways to the fullest extent, it was decided to build the bridge with a 125 ft cantilever on both ends of the bridge.

The role of the screening station has been mentioned several times in the previous discussion (Figure 11). It is critical to the whole sintering plant operation. Therefore, to better understand the design of the building and the reasons for the installation of the various conveyors and their arrangement, we should review requirements in conjunction with the sintering plant demands. First, based on a 75 per cent operating duty cycle, simultaneous operation of four screens was required part of the day. Furthermore, as noted on Figure 11, the belts that carry the screened material away from the screens are common to all of the screens. This, in turn, means that the same material must be fed over all four screens simultaneously. Based on this premise, it can be seen that if the screening station had been designed with one feeder per bin, we would have required four bins with the exact same material in order to operate four screens simultaneously. However, the sintering plant operation is based on using three different types of ores; therefore, in order to satisfy both requirements, a double pants leg was installed with two feeders on each bin, shuttles were installed such that two bins could feed four screens simultaneously, and six bins were installed to carry three different types of ore. Please note that the ore is fed from the feeder on to a shuttle which, in turn, feeds on to a belt feeding one of five screens; one of the five, in all cases, being a spare. Therefore, it can be seen that by the use of this bin construction, and with the combination of shuttles and feeder belts, maximum flexibility is obtained from the bins.

The stocking-out portion of the ore handling system, that is, conveyors C1, C2, C3, the stacker and auxiliary ore bridge commenced operation about April 1, 1956 and, following the completion of the ore screening station, the remaining portions of the ore handling system were operated. Concurrent with the completion of the ore handling system, the fourth sintering strand was placed in operation. Fortunately, only minor difficulties were encountered in the operation of the system and certainly all concerned, including the various departments in our Sparrows Point plant, the Lackawanna plant engineering department, and the conveyor manufacturers involved, are to be congratulated for a job well done.

Finally, before considering allowances made for the future, it might be well to point out the effect of the installation when the six sintering strands have been put into operation. Most of the ore consumed in the furnaces at Sparrows Point will pass through the screening station; the lumps being conveyed directly to the ore stock bins on the north trestle and the fines eventually are conveyed to the same location after being converted to a sintered product in the six sintering strands. Furthermore, as a result, most of the ore burden for the blast furnaces will end up in the ore stock bins over the north trestle; thus, it can be seen that the ore handling system and sintering strand installations have in themselves basically altered the whole ore handling picture in the blast furnace area.

1. Most of the ore delivered to the furnaces will be in the maximum beneficiated condition consistent with the process used.

2. Ore will be transported to the furnace stock bins mainly on the north trestle and be between the respective furnace and the ore handling stock bins. This represents a considerable departure from the present method of loading trestle cars on the south trestle and should speed up present handling in this portion of the system, because it is quicker to load trestle cars from bins rather than by bridge, and, in most cases, the route that the trestle car has to travel is shorter.

With all the current programs undertaken at Sparrows Point, no picture would be complete without pondering about future considerations. With this in mind, provisions were made for adding a future auxiliary ore field bridge by virtue of the fact that the reclaim cycle was designed for 2500 tons per hour.

It was noted in one of the modes of operation that ore can be loaded directly from the boat to the screening station. Obviously, additional bins in the screening station, beyond the six presently installed, would increase the amount of ore loaded directly from boat to storage, and, thereby, decrease the amount of ore that had to be transported to and from the auxiliary ore field. Additional bins also would allow for future possibility of handling four or more types of ores in the sintering strands. Provisions have been made in the screen bin design for installing two additional 1500-ton capacity

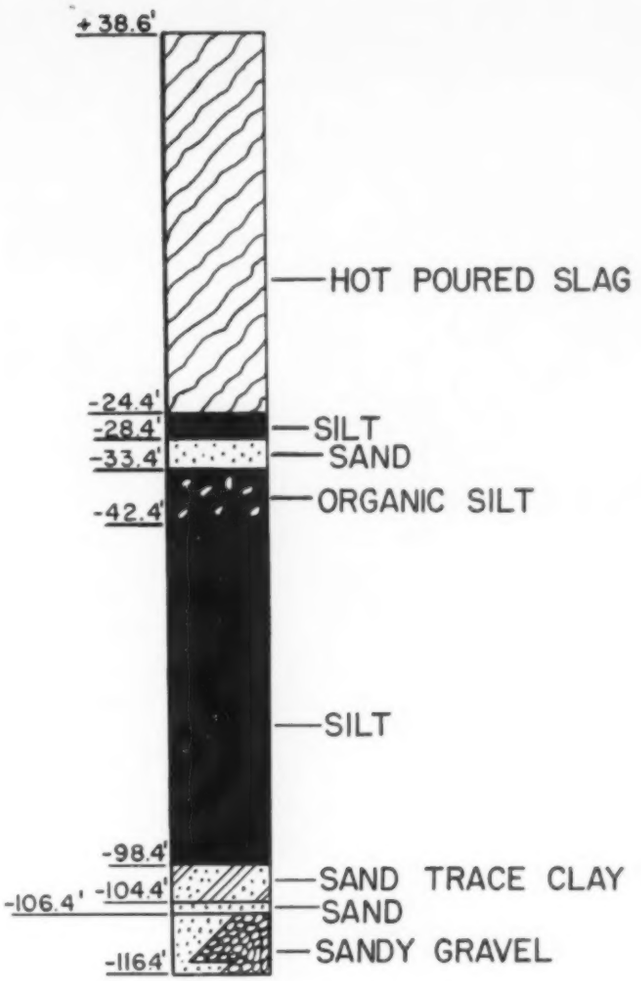


Figure 10 — Test boring in auxiliary ore field.

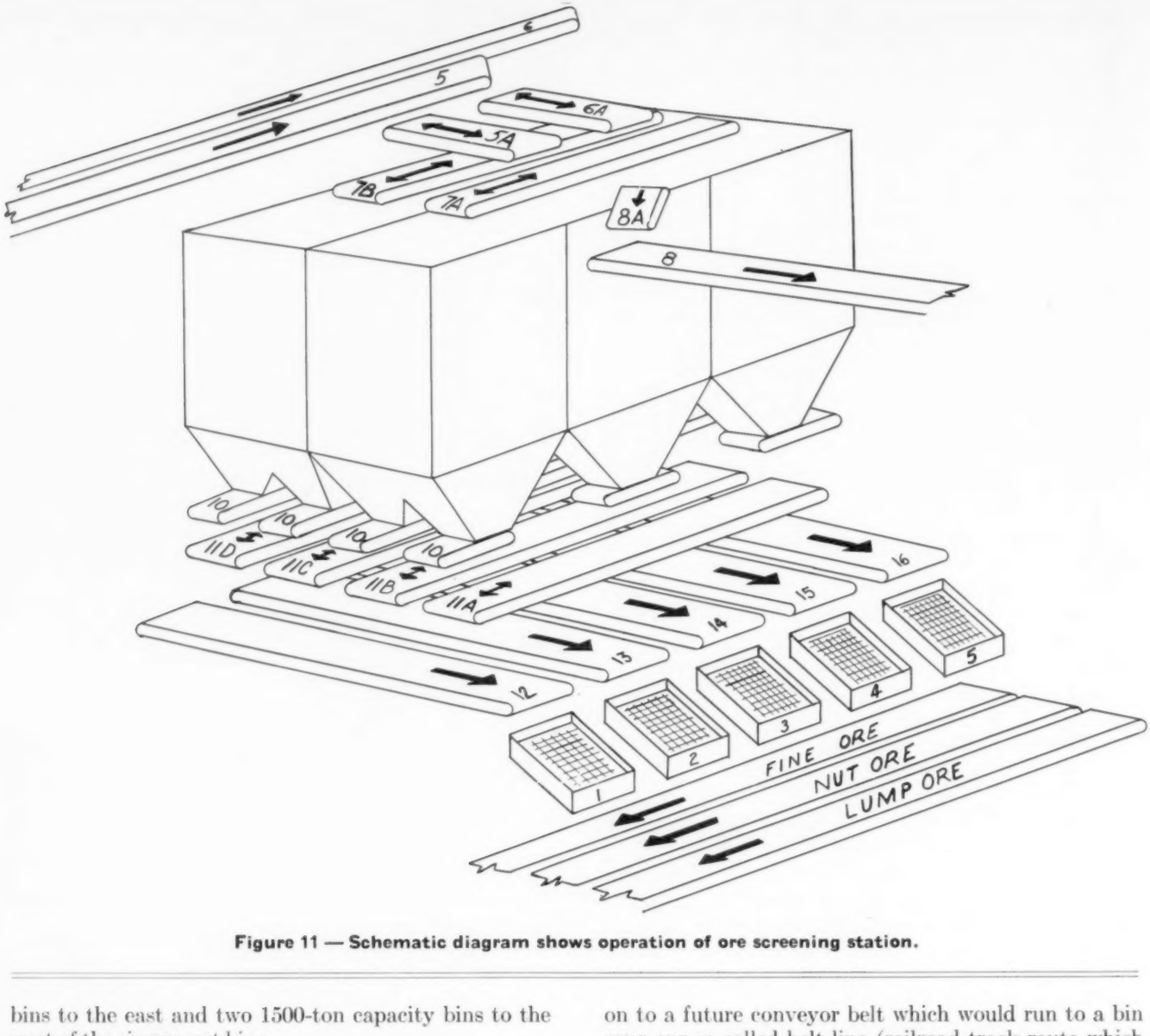


Figure 11 — Schematic diagram shows operation of ore screening station.

bins to the east and two 1500-ton capacity bins to the west of the six present bins.

Briefly, the role of the ore handling stock bins over the north trestle have been reviewed and it is only honest to say that the amount of bin capacity required is a somewhat indeterminate variable, and perhaps can only be established positively by experience. It is felt that the stock bin allowance for the contemplated sintering plant operation and blast furnace capacity is not excessive and that additional bins may prove to be useful. Accordingly, provision has been made in the installation to add an additional nine stock bins in the future, if necessary.

Another consideration of fundamental importance is provision for adding additional ore storage capacity and, therefore, the new auxiliary ore field and bridge conductor system were designed so that the field could be extended to the east.

Presently under consideration is an extension of C1 conveyor to the west end of the ore dock so that additional flexibility might be gained from the ore handling facilities.

Another provision that could be used in the future was the installation of conveyor C4A in drive house No. 2 in such a manner that it could discharge to the east on to a future conveyor belt which would run to a bin over our so-called belt line (railroad track route which circles the plant) for loading railroad cars with ore for shipment.

"ELECTRICAL FEATURES"

By E. C. OLSON

Assistant General Electrical Foreman

Sheet, Tin and Strip Mills

Bethlehem Steel Company

Sparrows Point, Md.

▲ THE electrical aspects of the ore handling and auxiliary ore field project are somewhat different from those normally encountered in steel mill work. In this paper an attempt will be made to give a brief de-

scription of the electrical aspects of the project, touching lightly on the planning of the power system, selection of motors and spares, control and interlocking, communications and the variable voltage ore bridge.

Work in the electrical department on this project started with a motor list recommended by a vendor, and it was known that a 20-ton ore bridge was part of the project. Management had previously given approval of the preliminary estimates and we were instructed to proceed with the purchasing and installation of the project. The first consideration was the type and quantities of power needed in the area. The area, at this time, had only two sintering strands operating and limited amounts of 440-volt a-c and 250-volt d-c power were available, although the area was not seriously limited in 6900-volt power.

It was necessary to decide on the power supply for the proposed ore bridge before deciding on the power system as a whole. Four ore bridges and four unloaders existed, all of the 250-volt d-c, constant-potential type. As there was no excess 250-volt d-c power available in this area, it was possible to start with the premise that 6900-volt alternating current would be primary power and design a system from this point.

Estimates were requested and received from vendors for the electrical equipment for the ore bridge, first as a 250-volt system, with an alternate as a 2300-volt a-c variable voltage system. The variable voltage system had a slightly higher first cost, due primarily to the cost of the large motor-generator set and other rotating equipment.

Detailed estimates were then prepared for the ore bridge and power system as a whole. First, as a 250-volt d-c system, including power rectifier, collector rails and bridge; then as a 2300-volt a-c system, consisting mainly of collector rails and ore bridge.

From the belt system motor list, it was known that 2300-volt power would be desirable for the three largest belts, as they were in the 300 to 400-horsepower range and thus 2300-volt power would probably be available in the area.

From these estimates it was shown that the variable voltage ore bridge would be the most suitable, not only from over-all cost, but also because of the many desirable electrical features and lower maintenance of the variable voltage system. From these estimates, it was decided that the ore bridge would be a variable voltage system, using 2300-volts alternating current as its main power supply.

We were fortunate in our studies to have an almost duplicate ore-handling system operating at our Lackawanna plant. From knowledge gained from this system and our own studies, it was possible to estimate the power requirements and proceed with the actual specifying and ordering of motors and the power system. Two 1500-kva, 6900/2400-volt transformers were purchased and installed, and one existing 500-kva 6900/480-volt transformer and small amounts of power from an existing 480-volt unit substation at the sintering plant were used.

Because of the approximately 3500-kva involved, 6900-volt, 3-phase a-c power would be primary power as it was readily available by extending the existing sintering plant bus. It was necessary to extend this bus by three cubicles, one breaker for the ore-handling system and one for each of the 1000-hp blower motors of the two new sintering strands.

Figure 1 — The two transformers at the auxiliary ore field are rated 1500 kva, 6900/2400 volts and the other is 500 kva 6900/480 volts.

Distributing power was fairly simple as most of the load requirements were concentrated in the three drive and junction houses. 6900-volt power was taken from the new breaker at the sintering plant and run north and south as three conductor cable, to the two 1500-kva transformers, one located at control house No. 2 and one near drive house No. 1 (see Figure 1). The transformer at control house No. 2 was to have two 2300-volt breakers, one for the ore bridge and one for the 2300-volt motors in junction house No. 3. An existing 500-kva transformer was located in the area of control house No. 2, along with the one 2300-volt transformer, to provide the small amounts of 480-volt power necessary for this area. One decision made primarily to suit the electrical design was to have the drive house located at the beginning of conveyor C3 instead of at the end. This shortened cable runs and decreased power losses measurably. The normal method is to have the drives pull the top section of the conveyor rather than the return side.

The other 2300-volt transformer also had two breakers, one feeding the 2300-volt motors in drive house No. 1, the other the motors in the screening building. The 480-volt power necessary for this area was supplied by an existing spare breaker at our sintering plant 480-volt unit substation. From the 2300-volt and 480-volt substations, practically all wiring was run in conduit to the various starters and control devices and then to the motors.

One special feature of the distribution problem was the collector system for the ore bridge, stacker and reclaiming hopper. In general, collector systems in mills and along the ore dock consists of steel rails supported on insulators and paralleling the runway. As the decision had been made to purchase the 2300-volt ore bridge, it was known that one collector system would be 2300 volts, but due to the small sizes of motors involved on the stacker and reclaiming hopper, it was necessary to install a 440-volt collector system for this equipment. From the arrangement of the field, it can be seen that these two systems parallel each other on opposite sides

of the collector supports. Now that the voltages necessary and the members of collectors were known, the next consideration was whether to use steel rail, as was plant practice up to this time. Estimates were made for a steel and also an aluminum collector system. Due to the fact that this was a new system, it was found that the over-all cost would be lower for the aluminum system. Aluminum systems could be purchased prefabricated; the supports could be made considerably lighter; and the installation costs would be less. This system has been in service almost a year now and has given excellent service (see Figure 2).

From the vendor's motor list, a total connected load of approximately 5000 hp was indicated. Due to the location and the split in motor sizes, the decision was made to purchase all motors of and above 250 hp as 2300 volts. This amounted to 13 motors for a total load of 3700 hp as 2300 volts. Three of these were 300 hp, seven were 250 hp and three 350 hp. One 250-hp and one 350-hp motor were purchased as original spares. It was possible to purchase the 300 and the 350-hp motors in the same frame size and thus eliminate the purchase of one spare motor. As these were all wound-rotor motors, the electrical manufacturer was asked to add a knife switch to the control of the 300-hp motors to reconnect the rotor resistance when the 350-hp spare was used in place of the 300-hp unit. It would seem that squirrel-cage, totally enclosed motors would have been more desirable, but to reduce starting and acceleration torques, it was found necessary to use wound-rotor motors. Starting torques on large conveyors must be rather closely controlled, otherwise belt damage can result. All the 2300-volt motors were purchased as dripproof, 40 C rise, wound-rotor motors with single standard straight shaft extensions, sleeve bearings and 110-volt space heaters. The space heaters were installed to prevent condensation during extended down periods.

All 440-volt motors were purchased as totally enclosed, fan-cooled, 55 C rise, squirrel-cage ball-bearing motors with shaft extensions as necessary. Most of these were normal-starting torque motors, but it was found necessary to specify some as high-starting torque, especially the traverse drives on the stacker and other similar applications. As our plant is of considerable size, it was possible to utilize spares from other areas and thus keep the purchasing of spares to a minimum. The one odd motor in this group was the one driving the stacker-boom conveyor. It was found necessary, because of the size of this belt, to use a wound-rotor motor and this necessitated the purchase of a spare for this single drive.

As can be appreciated, on any extended conveyor system where there are long unsupervised conveyors, various types of electrical protection must be provided. With these belts designed to move approximately 100 tons of ore per minute, it is not difficult to foresee the problems arising from a belt breakage or a malfunction going undetected for as brief a time as one or two minutes. To prevent piling material on a dead belt, all conveyors are interlocked so that if a belt, being loaded, stops, all previous belts stop. This means, of course, that these conveyors must be started in the reverse fashion. In other words, the last or final delivery belt must be started first and then the preceding, etc., back to the first belt being loaded. It is in general good practice to equip these belts with centrifugal switches, driven from the belt by rollers, to prevent belt breakage from going undetected. These centrifugal switches also serve as back-up electrical protection. If the belt does not start after a set predetermined time when the control indicates it should be moving, the switch will trip the control.

Figure 2 — An aluminum collector system was found more economical in over-all cost.

These belts have been designed so that there are eight different ways or combinations of ways to move material over them. Each time we choose a different material flow, we must alter the interlocking so that the belts will start and stop in a different sequence. This was accomplished by what was called a mode-selector switch. The operator decides where he wants the ore to go, and then selects the mode corresponding to this material flow which, in turn, through relaying, sets up the proper interlocking. On a system as long as this, we believe it necessary to make the controls as simple as possible and tried to arrange them in a pictorial fashion. The operator has mimic belts on his control stations and indicating lights are lighted along these as the conveyors are started. Shuttle conveyor interlocking was made a function of both belt direction and shuttle position in an effort to minimize operator error.

It was known, from past experience, that means of stopping these belts along the complete length would have to be provided. A limit switch type of device, manually resetting, was used and then a small wire (actually clothesline) was run along the length of the belt. In practice, we have one switch and then a tripping wire running in each direction for about 150 ft, so that one switch will service about 300 ft of conveyor. These were made manual resetting so that if one were tripped, the operator would have to go to the source of trouble and reset. Because of the distance involved and the fact that these switches would be on either or both sides of a conveyor, depending on where the walkways were, it was decided to install indicating lights on the control stations to tell an operator which switch had tripped.

There were two locations where interlocking was a problem. Along the ore docks, any one of five bridges or unloaders could be loading No. 1 belt. It was necessary to make the loading of No. 1 belt a function of No. 1 belt motion. It was possible to install an interlocking collector rail, but due to space limitations this did not seem very practical. Steel rails are used the length of the

ore dock to transmit power to each of the ore bridges, and it was possible to solve the interlocking problem by impressing a signal of approximately 12 volts at 133 kc on these existing collector rails. In other words, when conveyor C1 was running, this radio frequency signal was carried by the existing electrical collector system to each bridge and unloader and permitted them to load the belt from their hoppers.

This same problem also existed at the auxiliary ore field end of the conveyors, but with more complications as the last belt was reversible. Conveyor C3 is unloaded by the stacker which is free to move down a 1700-ft track. When loading to the auxiliary ore field, the stacker must be running before conveyor C3 can operate. Also, when reclaiming, C3 must be running before the reclaiming hopper can be permitted to operate. Both the stacker and the reclaiming hopper receive power from a common 480-volt aluminum collector system, and it was possible to solve the problem by superimposing a 12-volt, 72-kc signal on the 440-volt system when the stacker belt was operating with a receiver at control house No. 2, altering this signal to a relay operation and then into C3 control. This same system was used for the reclaiming hopper, only this time 133 kc was used to prevent interference with the stacker interlocking. To date, this system of interlocking has been very successful. This equipment is safe from failure. If there is a malfunction of the electronic interlocking, the conveyor in question will stop.

To keep the stresses within the belts within allowable limits, and to reduce the possibility of slippage between the belt and the drive pulley during acceleration, wound-rotor motors were used for all belts requiring a motor rating above 125 hp. Conveyors C2, C4, C6 and the stacker boom conveyor were driven by a single wound-rotor motor. In addition, a separate wound-rotor motor was provided to drive conveyor C2 in the reclaiming direction. Conveyor C5 utilizes two wound-rotor motors; one driving the primary pulley and the other the secondary pulley. Conveyors C1 and C3 have two wound-rotor motors geared to the primary pulley and a separate motor for the secondary pulley. In addition, conveyor C3 has another motor driving a different primary pulley in the reclaiming direction. Since the required reclaiming capacity is considerably less than the required stocking-out capacity, the reclaiming primary pulley was driven by a 250-hp motor, compared to the use of two 300-hp motors driving the stocking primary pulley and a 250-hp motor the stocking secondary pulley. During the reclaiming operation, one of the stocking primary motors is run at light load in the reclaiming direction; so that the stocking primary pulley will not act as a drag on the belt.

One of the main functions of a secondary pulley is to maintain good contact area between the belt and the primary pulley. For that reason, the secondary motor starts first and the acceleration steps are interlocked so that the primary motor accelerating peaks are staggered, but the secondary motor will accelerate with each primary motor. The conveyor manufacturer stipulated that the combined accelerating peaks of the primary and secondary pulleys must not exceed 150 per cent of rated belt load. This necessitated eight steps of acceleration in the 2300-volt, wound-rotor motor control panels. On the duplex primary pulley drives of conveyors C1 and C3, it seemed unnecessary to energize accelerating contactors for both primary motors simultaneously, since the peaks would only have to be limited to a low value in order to remain within the 150 per cent limit. For that reason, the acceleration peaks were alternated between the two primary motors.

Of course, permanent sections with taps for adjustments were provided in the secondary resistors. This allows adjustments for an equal division of load between the motors on the duplex primary pulley drives, to adjust the load on the secondary pulley motors during steady-state running conditions, and to adjust the speeds of succeeding conveyors in the flow of material. In addition, provision was made to test or jog each conveyor for inspecting or maintenance purposes. Without running the entire conveyor system. For emergency operation at reduced load, either motor on the duplex primary pulley drives can be operated with the other motor disconnected. Temperature links were also installed over the resistance banks, so that if a motor failed to accelerate fully and the resistance bank was in danger of failing, the temperature link opens, stopping the control in trouble.

The 2300-volt motor control panels were purchased as gasketed general purpose enclosures (NEMA Type 1A) as they were located in enclosed control houses. The 440-volt starters and operator control stations in general were located in operating areas or adjacent to the drives and were purchased with dust-tight enclosures (NEMA Type V). Control voltages in all cases were 110-volt alternating current.

It was very early recognized that good communications would be essential to the operation of this system. A wired audio system was installed along the entire conveyor. This consisted of a 150-watt amplifier, eighteen 12-watt speakers and 18 carbon button microphones. Each speaker-microphone station is set up as a unit consisting of a push-button microphone, speaker and volume control, all mounted in or on a water-tight box. When a microphone is used, the local speaker is muted to prevent feedback. This audio system is coupled to a 100-kc frequency-modulated carrier current transceiver located in control house No. 2. This, essentially, is the trolley phone system that ties the ore bridge, through its 2300-volt bridge collector rails, its variable-voltage trolley rails, and the stacker and reclaiming hopper through their common 480-volt collector rails to the audio system. Thus we have a common talk type system whereby any operator at any one of the stations can talk to all other stations including the ore bridge, stacker and reclaiming hopper. This system has been augmented by including a microphone speaker unit from the existing ore dock system at one of the new conveyor stations. This one man can then relay information from one system to the other without the congestion that would result if both systems were tied together.

It might be well to mention a few of the interesting features of the variable-voltage ore bridge as it is certainly an integral part of the system (see Figures 3 and 4). One of the first questions that was encountered was the type of motor to use for the main motor-generator set, synchronous or induction? From estimates, it was found that there was no large difference in cost be-

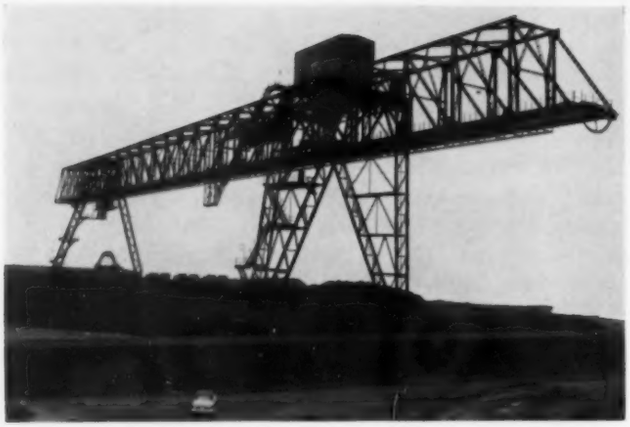


Figure 3 — Use of variable voltage requires a large electrical control house.

tween the two types of motors, and it was decided to purchase the motor as an 800-hp, 300 per cent pull-out torque squirrel-cage motor, mainly because of the more rugged design of the motor and the simplicity of the motor control.

The 20-ton ore bridge has a free-digging capacity of 1600 tons per hour over an average hoisting distance of 50 ft and an average trolley distance of 150 ft. The rated hoisting speed is 250 fpm and the rated trolley speed is 1000 fpm. The standard frame 618 self-ventilated hold-and-close line, 230-volt motors are operated at approximately 325 volts, and the standard frame 616 self-ventilated 230-volt trolley motors are operated at approximately 395 volts to obtain the desired speeds. Adjustable voltage operation of those motors is provided by a 5-unit motor-generator set, mounted in a pressurized room at the top of the pier leg of the ore bridge and above the trolley runway. In addition to the 800-hp squirrel-cage motor previously mentioned, this motor-generator set has two hold-and-close-line generators, each rated 250 kw at 325 volts, a trolley generator rated 400 kw at 395 volts, and a constant potential 50-kw, 250-volt generator. Because of the common-return connection, only nine collector rails are required between the trolley and the bridge structure. These rails are aluminum for previously mentioned reasons. All lights, heaters and auxiliary drives on the trolley are operated from the 230-volt, d-c constant-potential system, in order to eliminate the additional collectors that would be necessary to provide a-c power on the trolley. To provide light and heat on the trolley when the motor-generator set is not running, the bridge manufacturer provided a 220-volt, single-phase a-c outlet at the trolley parking location, with a transfer switch and protective relay on a trolley control panel. Miscellaneous a-c power for the rail clamps, motor-generator set room blower and lights along the bridge is provided from a 75-kva load center in the motor-generator set room.

The control includes many automatic features, such as dividing the load equally between the holding and closing lines when hoisting and matching the speeds of those two lines when lowering the open bucket. During the bucket closing operation, the operator can keep slack out of the hold line and still permit the empty bucket to settle into the pile by simply placing the hold line master switch in the first hoisting position, while

Figure 4 — Ore bridge loading and reclaiming hopper.

the close line master switch is in a faster speed point.

The trolley provides smooth acceleration and deceleration, with "Off" position coasting when running above 50 per cent speed, and with the operator having ability to control the amount of plugging torque by the position he selects for the trolley master switch in the reverse direction. Two steps of stop zone protection are provided at each end of the trolley runway, including automatic directional sanding, with the first stop zone effective above 600 fpm and the final stop zone effective above 200 fpm. In addition to shunt-wound trolley brakes for emergency stopping or parking, emergency dynamic braking is also provided with self-excitation of the motor fields.

To run the bridge, the operator simply steps on a foot switch, which results in raising the rail clamps and transfers the hold and close generators to the pier and shear leg drives. The operator can control the pier and shear legs independently by the hold and close master switches, within the allowable skew limits. If both bridge legs are in operation, automatic skew control is provided by means of 10-circuit skew limit switches controlling resistors in the generator field circuits.

This ore bridge has the common protective features, such as rail clamps, anemometer, control and power skew limit switches and control limit switches on the hoist motions. The rail clamps were fairly new to this operation as they are hydraulically operated. A 5-hp, 440-volt motor drives the pump that releases the clamps, the clamps being counterweighted to close when the motor stops.

It is doubtful if anything radically new was used in this project but it is believed that many practical and tested ideas were incorporated to make this system a complete and integral unit.

DISCUSSION

PRESENTED BY

G. C. LITTLE, Assistant Superintendent Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.

A. S. WAXMAN, Electrical Engineer, Blumenthal-Kahn Electric Co., Baltimore, Md.

R. W. SHEFFLER, General Supervisor, Electrical Engineering, United States Steel Corp., Fairless Works, Fairless Hills, Pa.

S. RIFKIN, Application Engineer, General Electric Co., Schenectady, N. Y.

R. G. BOTTORF, Engineer, Steel Mill Equipment, Link-Belt Co., Colmar Plant, Colmar, Pa.

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H. G. DILLON, Vice President, McKiernan-Terry Corp., Mead-Morrison Division, Harrison, N. J.

E. F. MICHAELS, Region Consulting and Application Engineer, Westinghouse Electric Corp., Philadelphia, Pa.

MELVIN BECKER, Engineer, Engineering Dept., Bethlehem Steel Co., Sparrows Point, Md.

E. C. OLSON, Assistant General Electrical Foreman, Sheet, Tin and Strip Mills, Bethlehem Steel Co., Sparrows Point, Md.

G. C. Little: I have one comment which should be added. We were very fortunate in having an ore handling system in operation at Lackawanna which, to some extent, does the same job as the one required at Sparrows Point. We were also fortunate in being able to obtain assistance from the Lackawanna engineering department. Most of the basic engineering for the Sparrows Point system was done at Lackawanna. The Sparrows Point system differs from the one at Lackawanna in that it has several more modes of operation and handles different ores. Most of the ores at Lackawanna are soft Lake ore while that at Sparrows Point has a high percentage of lumps. This necessitates a more extensive use of rock boxes and striking bars. We have found from experience, that the conveyors may be seriously damaged by falling ore. Therefore, everything possible was done to reduce the distance the ore would drop on to the belts.

A. S. Waxman: I never get much chance to look at the mechanical picture, so I am curious to ask how they measure the rates of ore flow. Looking at it from the electrical end, I do not think Mr. Olson really has left much to question. However, there are a few things I would like to point out about this particular installation, and possibly some of the steel mill control men can help us out on similar installations.

This particular set of conveyors, as you probably noticed, averages about 1500 ft in length. The control stations or operator stations are located at just the end of the conveyors.

The interlocking on the conveyors is comparatively complex, necessitating interconnections between possibly 10 or 20 different devices, before a completely closed loop is made. Now, with that particular type of arrangement, you wind up possibly with a total of 7000 or 8000 ft of wire in one closed loop circuit. This may result in so much voltage drop that you are unable to operate the relays in the closed loop. We found this would be the case on these conveyors, which necessitated reconnecting equipment so that all the devices in a particular control house could be interconnected before proceeding to the next control point. On an elementary drawing that looks like a very simple problem, but actually in a long series of conveyors like this, it becomes quite an involved system.

The other problem is one which is becoming more and more complicated in steel mill control design. That is the engineer making the control wiring fails to see the physical picture and his interconnections are made up as if there is no physical picture. This may be straightened out simply by recognizing the fact that from the installation standpoint you run normally one conduit with its required number of wires from an individual device to a control panel. To overcome the lack of flexibility in this particular installation it was necessary to add quite a few field terminals. In the later installations, such as the latter part of the ore-handling system, these additional terminals were added at the factory in such fashion that the connections could be made up quite simply. I think that is far more important and is becoming increasingly more important as these installations become more electrical-minded. For example, between operating stations and conveyor galleries we had as many as 200 control wires. This may become an elaborate maintenance problem. In addition, it is an involved installation problem to handle this number of wires along this length of conveyor.

With reference to Mr. Olson's paper, I would like to ask him what the comparison of cost is between an ore bridge using 250 volt, direct current and one of the latter types using 2300 volts alternating current.

R. W. Sheffler: In the 2300-volt transformers which are located very far apart is it deemed advisable to use tie-breakers in case you lost any one of the transformers?

It was quite surprising to me to note that you chose a squirrel-cage motor for driving the motor-generator set on the bridge. I would like to ask if you had to use booster cables along the collector rails or capacitors on the bridge. Also, on the stacker-collector rails, was it necessary to use a booster to keep the voltage up when the stacker got out to the end of the rails?

S. Rifkin: Once again, a thorough analysis of the over-all project verified that the use of adjustable-voltage on the ore bridge would result in a lower over-all cost for the installation, since 250-volt constant-potential direct current was not readily available at the ore bridge site. Furthermore, when comparing the cost of an ore bridge using adjustable-voltage main drives with the cost of a bridge using constant-potential d-c main drives, a fair comparison must be based upon free-digging capacity, not on comparable motor frame sizes.

The 230-volt, AISE standard mill auxiliary motors can be operated on adjustable-voltage drives at approximately double voltage; thereby providing double speed at rated torque, or, in other words, approximately double horsepower. On the Sparrows Point bridge, other factors resulted in the decision that full advantage would not be taken of this possibility. The

hold and close motors were run at 325 volts, and the trolley motors at 395 volts.

The many automatic features that can be incorporated in rotating regulator adjustable-voltage controls are quite intriguing. For example, placing the hold line master switch on the first hoist point while the bucket is being closed at a moderate or fast speed, will take slack out of the hold line and still let the weight of the bucket dig into the pile for a full load. But, if the operator places both master switches in the first hoist point, the loaded bucket will be held or raised at slow speed. When raising the loaded bucket with both master switches in the full speed hoist position, the load will be divided equally between the hold and close lines, but if the operator wishes to dump a load "on the fly" while continuing some raising motion, he need only move the close line master switch to a slow speed point in order to remove the load dividing circuit. Similarly, when lowering a closed bucket at full speed, the load will be divided equally between the lines; or when lowering an empty bucket at either the fastest or slowest speeds, the motor speeds will be matched to keep the bucket open. These features do not prevent closing or opening the bucket as it is being lowered, because the operator can interrupt the speed matching circuit by moving one master switch into a different speed point than the other.

The trolley control gives the operator a choice of—not one or two—but five different plugging torque values. As the operator moves the master switch farther in the reverse direction, the magnitude of the plugging torque is increased. This provides excellent control for all types of rail conditions and should help the operator to take undesirable swing out of the bucket.

On the conveyors, the eight different modes of operation presented many interesting interlocking and selection problems. Also, the necessity of limiting the maximum combined accelerating peaks to 150 per cent of rated belt load (not rated motor load) required tailor-made designs for each accelerating resistor. For some belts, the effect of machine inertia had to be taken into consideration in determining the peaks at the pulley; otherwise more steps of acceleration would have been considered necessary in order to stay within the specified value. On C1 and C3, the decision to stagger the accelerating peaks of the primary pulley motors made it possible to utilize only four accelerating contactors on each primary pulley control panel, along with eight accelerating contactors on the secondary pulley panel; thereby conserving space and material.

Robert G. Bottorf: At the risk of differing with Mr. Little, I would like to talk about the absence of duplication with the previous system at Lackawanna. At Lackawanna, there was developed, it is true, an original design, but the operating concept was limited to three modes of operation, with a possible future fourth. You will note from the paper that the basic design of this system covered eight modes of operation, with provision for, I believe, four more in the future. Therefore, it is hardly fair to compare a three-mode design with a twelve-mode design.

Also, I will agree with Mr. Little, that the types of ore at Lackawanna are somewhat softer than those that the original design at Sparrows Point contemplated. I believe since the plant has been in operation, you are getting ore having handling characteristics that you did not expect down there. Here again, it speaks well for the design anticipation of Mr. Becker and Mr. Olson that even though there is an unexpected and intangible set of things to contend with, the system seems to be handling the various types of ore very well.

One question I would like to ask Mr. Becker: At Sparrows Point you are not 100 per cent dependent on the auxiliary ore field and the belt conveyor system. You had an existing plant with an ore field adjacent to the blast furnace line, which is typical of most steel plants. At Sparrows Point and Lackawanna your company added auxiliary fields to obtain more storage capacity in the closest area that could be found to handle geographically the tonnage you would like to store now and, also, the tonnage that you might want to store in the future.

We have been reading in our local papers in the last year or so of two more potential steel plants along the Delaware River Valley. I believe National Steel is one and Phoenix the other. Also, with the advent of the St. Lawrence Seaway, it is conceivable that you might, in the future, with population growth the way it is going, be faced with more possible steel expansion in this area or perhaps somewhere else in the United States.

The question is this: At Sparrows Point with your eight present modes of operation and four more projected, only one, I believe, of the total involves unloading of ore into a field adjacent to the furnaces and reclaiming from that field to the transfer cars on the trestle. On these future plants is it conceivable that you can, in the beginning, select an area to give you the geographical qualities that you need for present and future requirements, whether or not such an area would be immediately adjacent to the furnaces? In other words, you would depend 100 per cent on a belt conveyor system from the unloading point of the raw material into the storage area and from the area to the vicinity of the furnace.

I was building up to the plants of the future.

W. O. Smith: I have two questions for Mr. Olson on the electrical aspects of the ore bridge. First, I wish he would elaborate on the air cleaning equipment for the motor-generator house. It appears from the pictures that the motor-generator house is quite high above the ground, and perhaps its height prevents a lot of dirt from reaching the house. I would like to know what method of air cleaning is used. If mechanical filters are used, are they disposable type or are they renewable oil spray type?

The second question is related to the subject of interlocking and protective devices which was discussed. I would like to ask if it was felt that interlocking schemes or safety devices are required to prevent two adjacent ore bridges from colliding during operation.

H. G. Dillon: One of the things that makes a job like this tough is the fitting of new equipment into old equipment. We happen to have had a little part in this work. We revamped the pier leg end of the two old bridges to accommodate a hopper and feeder for the conveyor belt. This work included a new hopper, weigh hopper and carloading equipment. New drives for the old trucks were substituted for the old line shaft drive equipment.

Engineering departments in the builders' organizations always hate to go back into these old jobs—the drawings are old, the records are old, stress sheets that must be studied were made years ago by people who are no longer alive, and you people have made changes in the field. We almost have a first-class sitdown strike when we ask our engineers to undertake the revamping of an old job. It is generally much more difficult to revamp one of these old jobs and make it fit into a changed picture than it is to build an entirely new job.

E. F. Michaels: My purpose is to answer a question on the possibility of designing or the use of other types of control on conveyor systems. We have found that static type control is very applicable on conveyor systems, and that it is particularly good where you have many signals feeding into the control. Conveyor systems usually require long leads and this is also well taken care of in a static control system because of the small magnitude of current used. I hope this answers the question about other types of controls that can be used for conveyor systems.

Melvin Becker: First, briefly, I would just like to touch on Mr. Little's comments regarding the difference in ores between the Lackawanna plant and that used in Sparrows Point—and as he pointed out, they had a considerable effect on the design of the handling system at Sparrows Point. That difference in ores required considerable study and thought for all the transfer points; and, to really understand what was done at those transfer points in the way of impact, beams, rock boxes, etc., would require two or three detailed sketches.

Mr. Waxman commented on the rate of ore flow in the ore handling system, and although I considered his comment to indicate whether we were weighing the ore on the ore handling system, I would like to point out that most of the ore goes to the screening station, and from the screening station the screenings go to the sintering plant. The ore is weighed on the sintering plant conveyor system which contains the belts for the lump and finer ore and, of course, the sintered ore.

Another point of interest is the basis of designing and setting the 6250 tons per hour for the stocking out cycle and the 2500 tons per hour rate established for the reclaiming cycle. The 6250 tons per hour figure was based on five unloaders loading simultaneously on the C-1 conveyor, which comes out to 1250 tons per bridge. The tonnage that each bridge can handle was based on experience and on previous studies that were made along the dock area.

The auxiliary ore field contains one bridge, but was designed for a two-bridge operation—one in the future, and two times 1250 tons per hour per bridge comes out to a 2500 tons per hour rate for the reclaim cycle. However, because of the longer run the bridge requires to load into the reclaim hopper in the auxiliary ore field—that is, from the far point of the field or middle of the field to the reclaim hopper, as compared to the relatively short run along the dock area, from ship into a hopper in the bridge—we anticipate that one auxiliary ore bridge will be able to handle on the order of a thousand tons per hour.

Mr. Bottorf mentioned that we had eight modes of operation, and he also indicated that the system was designed for four in the future.

The additional modes, if I understand Mr. Bottorf correctly, will involve running conveyor 4-A in a reverse direction on to future conveyors that would go out over a belt line for the purpose of loading ore for outbound shipments. This operation alone, and in combination with loading ore from the main ore field to the screen bins or stock bins, constitutes several future modes of operation.

The next question was the dependence on the auxiliary ore field at Sparrows Point, and I think to answer that I would like to reread a small portion of my paper. As I pointed out, the growth of ore requirements in Sparrows Point plant and changes brought out by new ore sources increased ore requirements in the blast furnace area in excess of the available storage areas. The following manner of handling excess inventories by truck to an area where the auxiliary ore field is now located, and returning the ore to the existing ore field presented a case for justifying a more efficient ore handling system, plus inability to feed the screening station for a six-sintering strand operation.

I read that again because I believe those are the two main points of justification for the Sparrows Point installation as compared to Lackawanna. Sparrows Point is an ice-free port, and shipments of ore arrive all year round, while, in comparison, Lackawanna receives ore shipments only a part of the year and it is necessary for them to use the ore inventory in their auxiliary field for furnishing ore to the blast furnaces before the start of the shipment season.

The next question I believe Mr. Bottorf mentioned was the possibility of using the belt system throughout to handle the ore to the blast furnaces. As I previously mentioned, our main ore field is bounded by a trestle system on the north and south sides, and the ore handling belt system has had a sizable effect on the usage of these trestles, inasmuch as most of the ore required for blast furnaces will end up in the ore handling system stock bins on the north trestle. Therefore, trestle cars will be loaded at that point and then ride along the north trestle to the respective furnaces, as compared to the past operation where a considerable amount of cars were loaded on the south trestle. To that extent the ore handling system is, I believe, feasible. However, if I interpreted Mr. Bottorf's question correctly as to devising a method for using a belt system to go from the ore handling system stock bins to the various blast furnaces direct, I would like to point out that handling a number of types of ores on a belt system presents complications.

Although the majority of our blast furnaces are located directly behind the main ore field, we have four furnaces located to the west, beyond the location of the ore field, and behind those four furnaces are coke ovens. Now, what that means is this: If we were handling the material by a belt system, we would probably require bins capable of receiving all of the different types of ores, coke, limestone, etc., for those blast furnaces beyond the ore field. The problems of designing and building a belt system, and incidentally the many bins that will be required in order to handle the multiple numbers of ores, is such that it is hard to beat a bulk handling system, such as the trestle cars, for that type of problem. Mr. Bottorf may disagree with me and certainly every case has to stand on its own merits; however, we have looked at the possibilities at Sparrows Point of

actually tearing down the trestle systems because there is no question they are burdensome to maintain and, if possible, we would like to get rid of them. However, it does not look at this point like we can do so.

I would just like to say, in reference to Mr. Dillon's comments, that the bridge manufacturers and especially those who had to help us in the engineering and modifications to old structures, did a magnificent job.

E. C. Olson: Mr. Waxman raised the question of weighing or measuring the rate of ore flow. Actually, we do not weigh the ore while on this conveyor system, although it is weighed in the sintering plant. Ore flow is controlled by varying the speed of the feeder tables located under each hopper. In all cases these are constant potential machines using rheostats for speed control.

I can only agree with Mr. Waxman that it is important that the manufacturer have a good knowledge of the physical arrangement of a system. On most processing lines, this aspect can be ignored but in a large physical arrangement such as the ore handling system, it is important that the manufacturer have a good concept of the arrangement.

Where feasible, it is good practice to return wiring from protective devices to the panel board terminal blocks after each such protective device rather than have a number in series and bring only the two end wires back to the panel board. This arrangement, while requiring more terminal blocks and wiring, pays for itself by the increased ease of maintenance and easier, quicker trouble shooting.

Mr. Waxman also had a question about the difference in price between the 250 volt d-c bridge versus the 2300-volt a-c variable voltage ore bridge. I believe you will find the difference in cost in electrical equipment to be about $50,000 in favor of the 250 volt, d-c system, which is just about the price of the additional rotating equipment. Certainly there is a small additional cost due to the larger control house necessary to house the main motor-generator set, but I believe you will find this to be a relatively minor item. When comparing the two systems, costs of the power rectifiers, transformers and collector systems must also be compared and, in many cases, will justify the variable voltage system. We would also expect the variable voltage system to be easier to maintain.

Mr. Sheffler questioned the feasibility of tie breakers between the two 2300-volt transformers. This was considered, as tie breakers can offer good insurance against transformer failure, but considering the reliability of the present day transformers and the fact that this is an intermittent duty system, the tie line could not be justified. It should also be noted that the loss of either transformer would only reduce the number of modes that could be used and would not cause a complete system failure.

The cost of the squirrel cage motor was compared to the cost of a synchronous motor-generator set, along with control and we found price to be essentially equal. The decision was made in favor of the squirrel cage motor as the simplified control and the more rugged type of motor made this the more suitable.

It has not been found necessary to add booster cables or capacitors as we have had no voltage problems even at the ends of the 1700-ft collector.

We purchased and installed the oil bath type of air filter but we have found that it is not necessary as there is very little dirt at the height of the control house.

We do not have our ore bridges interlocked to prevent collisions, mainly because we have not found a suitable means of doing so. We are investigating an electronic means of doing this at present.

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Application of Static Switching in the steel industry

. . . . adoption of relatively complex automatic control on mills is justified by increases in quality production because of consistent and accurate control of the mill at its optimum efficiency . . . . static switching elements and logic controls provide a new outline for such control . . . .

By D. L. PIERCE
Assistant Manager Control Dept.
Motor and Control Div.,
Westinghouse Electric Corp.
Buffalo, N. Y.

▲ THE constantly increasing demands for better quality and higher production of basic materials, such as steel, have resulted in the application of automation principles to machines which normally in the past have been manually controlled by human operation. As a result of replacing the human operator with more precise and automatic control equipment, the complexity of industrial control equipment has grown tremendously in the last five years. This is particularly true in the steel industry. The next five years will probably result in an even greater growth of intricate systems.

With the increase in the number of systems and the trend toward more automatic operation of mills, it requires additional interlocking and co-ordination of electrical intelligence between systems. This compounds the over-all system complexity and problems of maintenance.

High production industries cannot tolerate any appreciable amount of downtime to correct trouble or for general maintenance. Electrical systems as such, particularly of the relaying and interlocking type, do not give trouble in themselves once they have been put in proper operation and meet the particular needs of a mill or machine operation. The troubles arise from failure or malfunction of components. With the rapid increase in the number of complicated control systems, the future maintenance problem will become overwhelming unless a major improvement is made in the life of some of the commonly used components.

Fortunately, with the advent of new and additional knowledge in the field of magnetic materials (particularly square loop type) and solid state physics, static switching has now become a commercial reality.

Industrial control systems can be divided into two

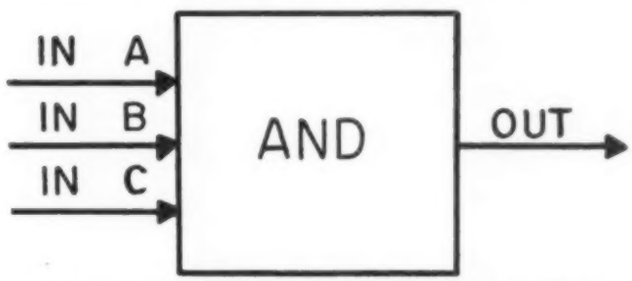
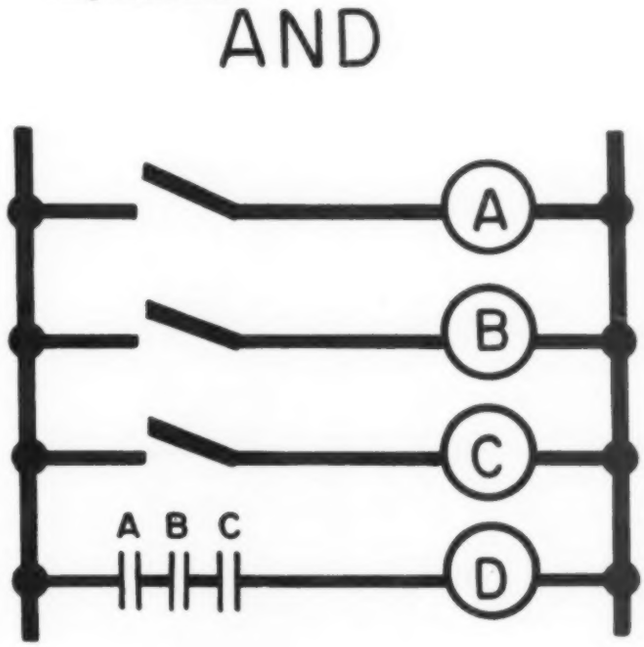


Figure 1 — Schematic illustrates *AND* function.

Figure 2 — *AND* function is analogous to this conventional relay series circuit.



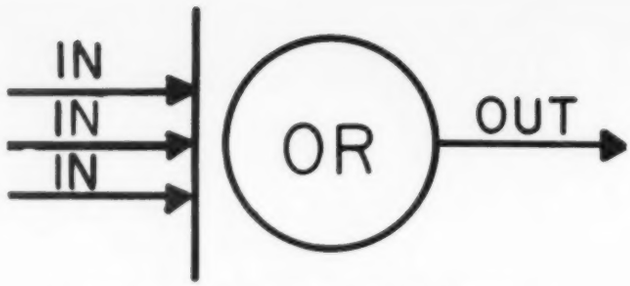


Figure 3 — Schematic illustrates *OR* function.

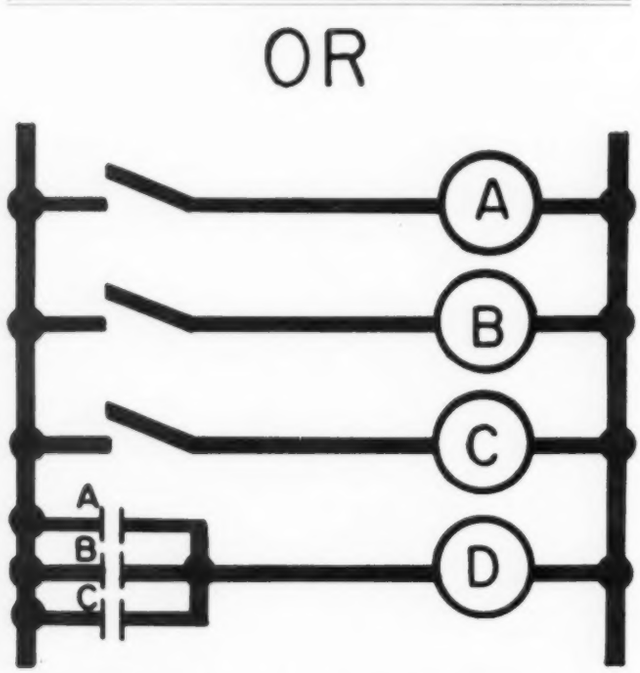


Figure 4 — *OR* function is similar to circuit with parallel relay contacts.

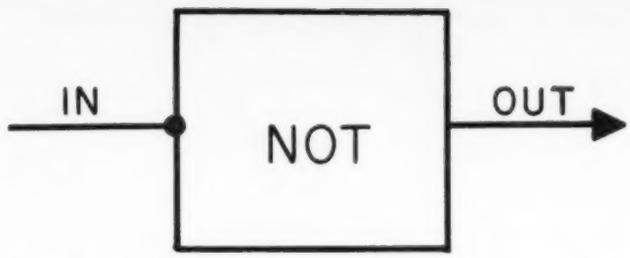


Figure 5 — Schematic illustrates *NOT* function.

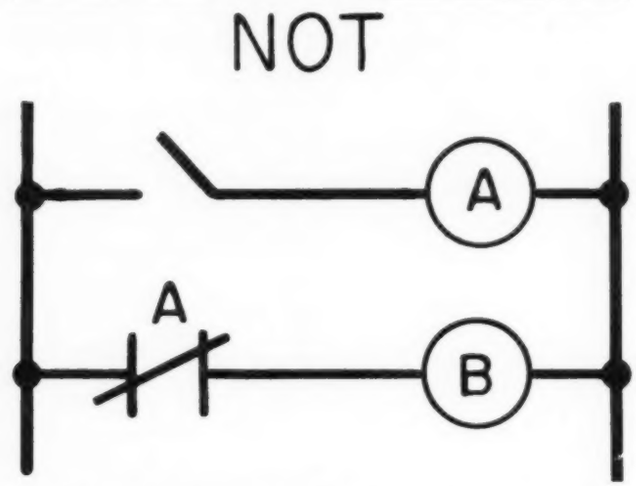


Figure 6 — *NOT* function in analogous to a circuit with a normally closed relay contact.

main categories—analogue and digital. An example of the analogue type is a continuous regulating system or control with a tachometer generator attached to a d-c motor to indicate speed; and in case of error, the tachometer supplies a signal directly proportional to the speed to raise or lower the field current in order to maintain the motor speed at a constant value. Digital is the term used to designate the full "on" or full "off" type of control, which commonly employs magnetic relays. The digital type of industrial control using static components having no moving parts was first introduced about two years ago.

Digital control systems using static components require four basic functions to perform electrical intelligence. They are *AND*, *OR*, *NOT*, and *MEMORY*.

The *AND* function has multiple inputs, all of which must be present at the same time in order to obtain a single output. Symbolically, this is shown in Figure 1. Inputs at A and B and C are required in order to have an output. This is similar to a conventional relay series circuit where contacts A, B and C must all be closed in order to energize coil D as shown in Figure 2.

The *OR* function shown in Figure 3 has multiple inputs. If any one is present, an output will be obtained. This is similar to a circuit with parallel relay contacts as shown in Figure 4.

The *NOT* function, Figure 5, provides an output without any input signal. When an input is present, there is no output. This is similar to a normally closed relay contact in a circuit illustrated by Figure 6.

The *MEMORY* function, Figure 7, gives an output when there is an input at A. It maintains that output even after the input at A is removed and continues to provide an output until another input is applied to turn it off. This is similar to the relay circuit shown in Figure 8 where a "start"-"stop" pushbutton "A"-"B" is used to energize and denergize coil D.

Commonly used industrial control relays have a limited life expectancy. They have moving parts subject to wear and hammering as well as electrical contacts that continually burn away.

Observation over the last 15 years of the approximate life expectancy of the available industrial-type magnetic relays without excessive maintenance provides data for plotting the curve shown in Figure 9. Extrapolating this curve into the future gives little hope of securing any great increase in relay life.

The principles of ferromagnetism have been known to man for centuries. It is only in the last sixty years that any appreciable improvements have been made in iron core materials; one of the first being silicon iron, and more recently, square loop core materials have been perfected.

Semiconductivity has been known for about 25 years. In the last ten years, the advancement has been very rapid.

When looking fundamentally at how a relay operates, Figure 10, if voltage is applied to the operating coil gradually, the contacts stay in the open position until the voltage is high enough to close the armature. At this time, full output is obtained through the contacts.

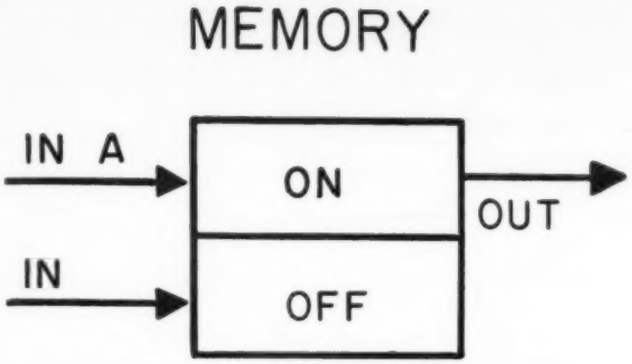


Figure 7 — Schematic illustrates *MEMORY* function.

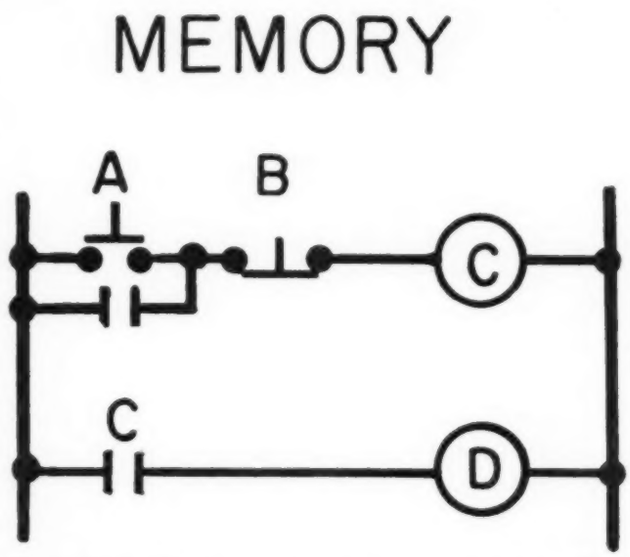


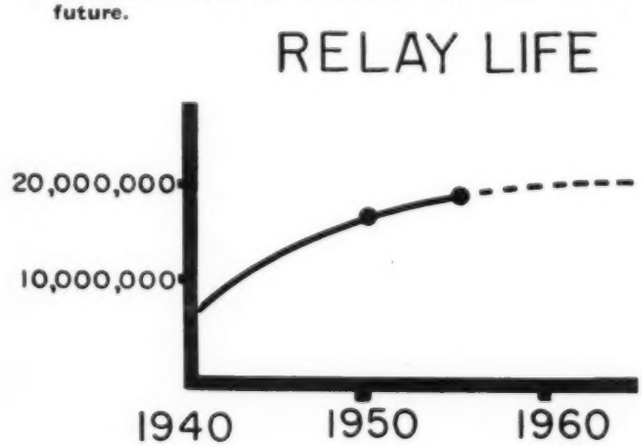
Figure 8 — *MEMORY* function is similar to relay circuit which provides an output until another input is applied to turn it off.

If the voltage is lowered, the contacts stay closed until the voltage drops low enough for the armature to open. The contacts then open and there is no longer any output through the contacts.

Looking at the hysteresis curve of square loop magnetic material, Figure 11, it is seen that this is very similar in shape to the relay loop. The main difference being that the iron employs magneto-motive force for the operating means and an iron saturation state as equivalent to relay output.

To usefully employ this square loop material principle means must be devised to obtain the "on" and "off" condition the magnetic material is capable of assuming in an electrical circuit. This can be done by winding a coil on a magnetic core with sufficient turns so that the peak of the applied a-c voltage wave is just enough to saturate the core. Then if a blocking rectifier is put in the circuit, as shown in Figure 12, and the core starts unmagnetized, the first half cycle of a-c voltage, which is in the conducting direction of the rectifier, will be absorbed in magnetizing the core and only a small magnetizing current will flow. On the second half cycle, the voltage is blocked by the rectifier and no current flows. On the third half cycle, since the core has remained saturated from the first half cycle, full voltage at the load is obtained and current will flow. Current will continue to flow in each alternate half cycle until means is applied to bring the core back to the unsaturated condition.

Figure 9 — Relay life has improved, but curve indicates no appreciable expectation of vastly improved life in the future.



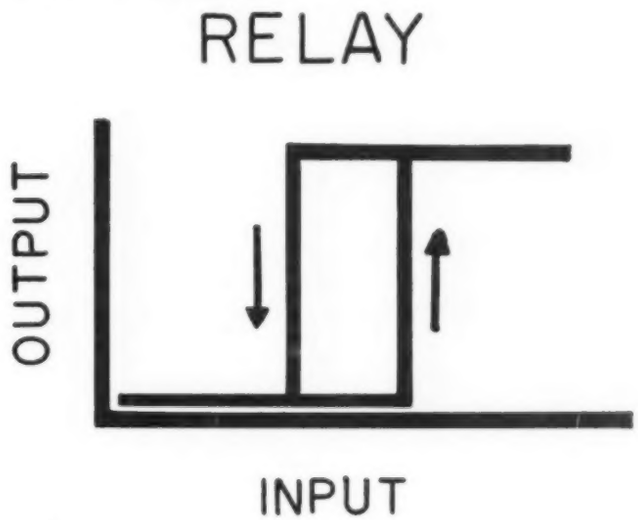
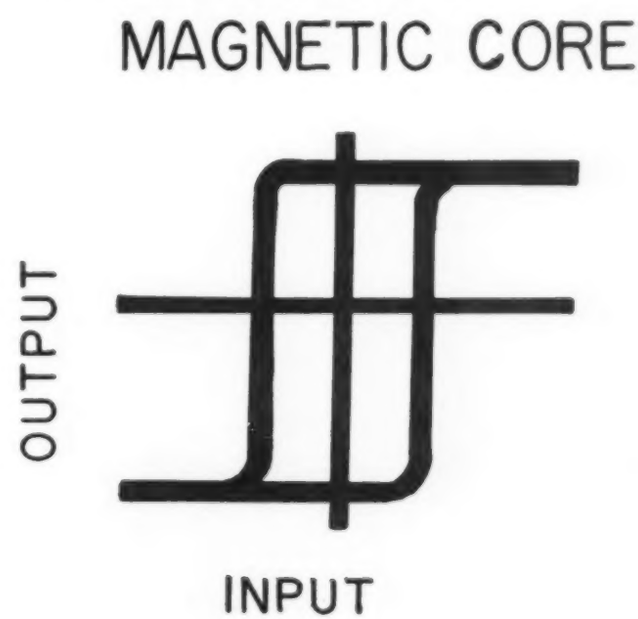


Figure 10 — Schematic shows relay operation and curve.

Figure 11 — Hysteresis curve of square loop magnetic material is similar to relay operation curve.



Next, a second winding is added to the core, as shown at the left in Figure 13, along with a blocking rectifier. A-c voltage is applied to this coil circuit and the rectifier blocks the half cycle that flows in the output circuit but passes the other half cycle that does not.

The left hand coil is wound in such a direction that the half cycle of current that flows through it produces a magneto-motive force opposite to that produced by current flow in the output circuit, and hence will demagnetize the core and drive it to negative saturation.

This now provides the means for controlling the output. If no voltage is applied to the reset winding at the left, the core will saturate and an output will be obtained. If voltage is applied to the reset winding, reset current will flow every other half cycle and will force the core to negative saturation after each half cycle that the load voltage takes the core to positive saturation. Hence, the load voltage is continuously absorbed in taking the core from negative to positive saturation and no output is obtained. This gives a *NOT* function as there is always an output whenever there is no reset control input present. Conversely, there is no output when there is an input.

Developing the circuit of Figure 13 further to that shown in Figure 14, an input V1 is added through a rectifier. Alternating current is applied continuously to the reset winding at the left as well as to the load winding at the right. With no input voltage applied, the core is continuously reset and no output is obtained. If voltage is applied at V1, which is equal to or greater than the a-c reset voltage, it will block flow of any reset current and an output will be obtained on the load side. This function is then known as one input *AND*.

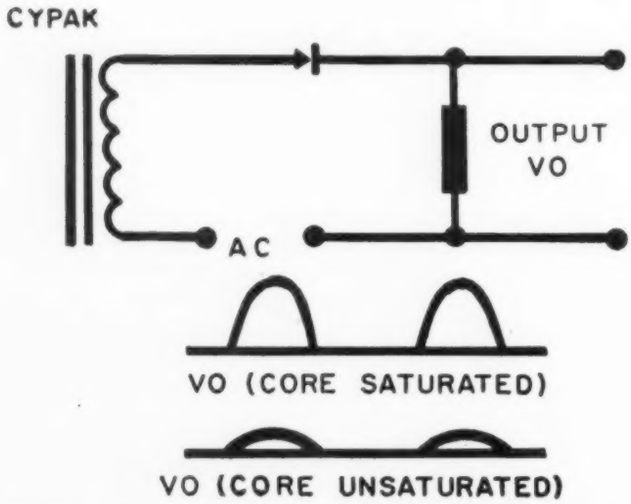
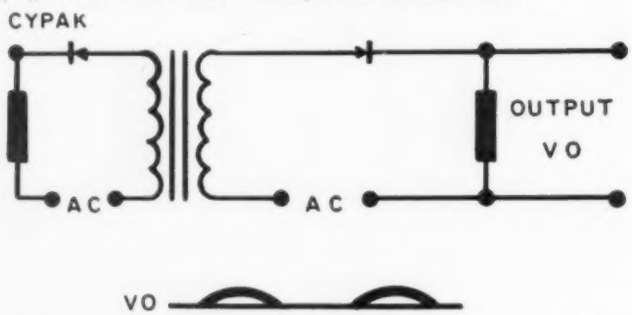


Figure 12 — Output coil is applied to magnetic core.

Figure 13 — Core here is output coil and reset coil.



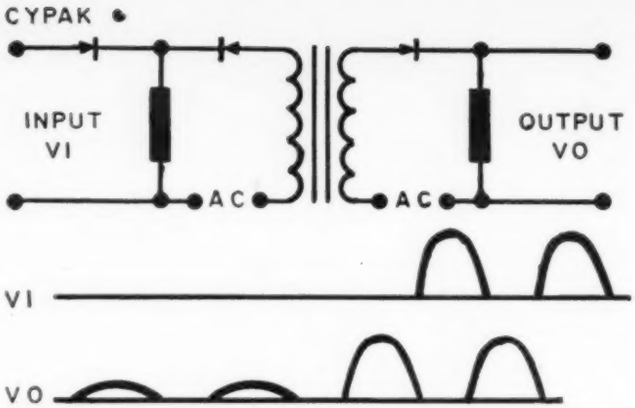


Figure 14 — Schematic shows 1-input *AND* function.

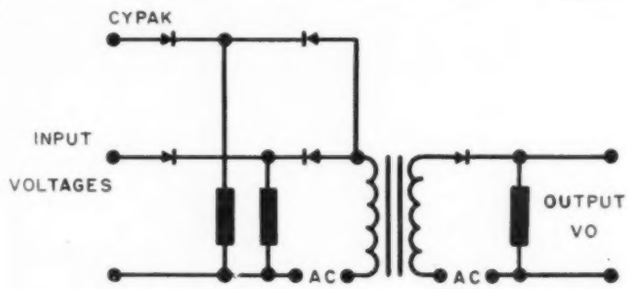


Figure 15 — Schematic shows 2-input *AND* function.

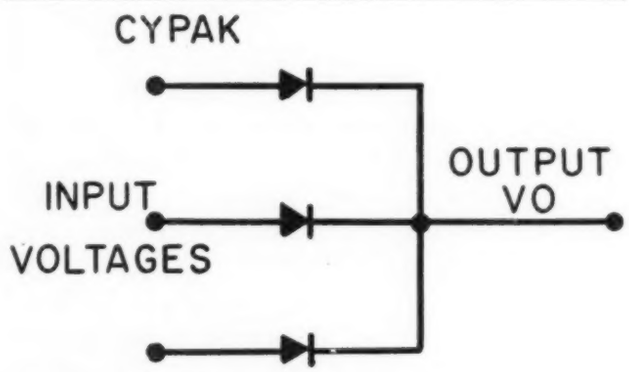


Figure 16 — Schematic shows 3-input *OR* function.

A second input can be readily added as shown in Figure 15. Application of a single input will not block the reset voltage as the other path is still open and reset current continues to flow.

In order to block the resetting, it is necessary to have both inputs present at the same time. When this is done, an output is then obtained and the function is a *two input AND*.

A multiple input *OR* is obtained merely by the use of rectifiers, as shown in Figure 16. The rectifier type *OR* function does not have any time delay.

Any electrical control system, now composed of a multiple number of magnetic relays actuated by push-buttons and limit switches whose output operates magnetic contactors controlling motors, can be duplicated in the exact over-all functioning by a static switching system. In more simple terms, static switching elements can be substituted wherever relays are used. The change, however, is not quite as simple to execute as it sounds.

To build controls using static elements instead of relays requires a different engineering approach and

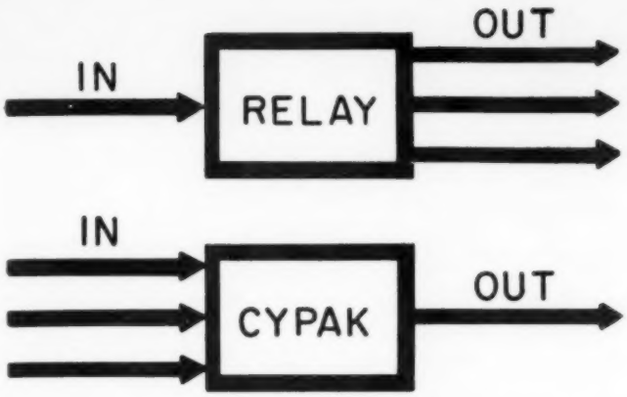


Figure 17 — Static switching elements usually have multiple inputs and one output.

entirely different thinking than has been used in relay systems. There are many fundamental differences between relaying and static systems.

Relays normally have only one input to the magnet coil which closes the armature and multiple outputs which are secured from the normally opened or closed contacts. Static switching elements generally have multiple inputs and only one output as shown in Figure 17.

A relay with normally open contacts has no output when there is no input to the operating coil. It has an output only when there is input to the coil. In the static switching *NOT* element, to obtain an output there can be no input; and to obtain no output, an input is required. This presents an entirely different problem than in the case of relay systems for building controls which will fail safe. Likely, each individual control scheme devised will need to be checked for all possible failure conditions.

Past history on industrial control clearly indicates that with the present control components, the minimum satisfactory voltage is 110 volts. Anything less, subjects the control to too much trouble from contacts not making circuit due to small particles of dirt and contact corrosion.

There are many advantages gained in using voltages less than 110 volts in static switching. The principal ones are size and cost. In order to take advantage of this, static systems now being built operate at lower than 110 volts. The system just described operates at approximately an 18-volt level. Also for size reasons, the power level is low. Consequently, in order to operate power handling contactor magnet coils, it is necessary to use a magnetic amplifier between the static system output and the contactor coil; or, in some cases, low energy relays. The input power to operate one of the static switching elements is about 10 milliwatts and the output is about ¼ watt. The symbol used for a magnetic amplifier output is shown in Figure 18.

Static systems on the market today for industrial control application are all built around the magnetic core principle. The reason for using the magnetic element is primarily due to its present state of reliability and known performance. Magnetic amplifiers have been used by the hundreds as Class A amplifiers in feedback control systems for several years. They have been applied on all kinds of applications. After

Figure 18 — This symbol is used for magnetic amplifier output.

initial setting, they function properly without adjustment, as they maintain an absolute stability of characteristics.

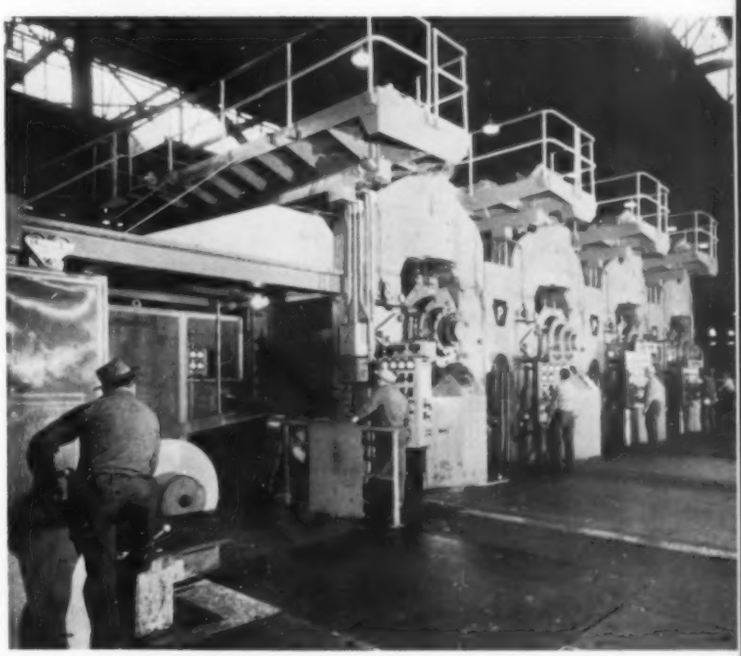
Many hundreds of magnetic amplifier regulating systems have been applied and are in operation in the steel industry alone. In checking back through the operating experience on many of these systems in service, it has been found that none of these have failed or given any trouble, and that maintenance on them, as reported by their users, has evidently been nonexistent.

The world's first completely magnetic amplifier controlled tandem cold reduction mill was placed in service at the Pittsburgh Steel Co. in 1954, Figure 19. No adjustments have had to be made on the magnetic amplifiers used on this mill since the mill was started. This substantiates the claim that such devices are extremely reliable.

The first industrial static switching system was applied to an automatic bus duct welder at our Beaver plant in late 1954, Figure 20. This has been in continuous production service since installation and requires no maintenance on the static control system. Prior to this, when relay control was used, weekly servicing was required on the relays.

Another early application of static switching was on a torus vane loader. This machine automatically loads 36 vanes in the half torus of a hydraulic coupling. It has been in production operation since the Fall of

Figure 19 — Automatic cold reduction mill at Pittsburgh Steel is completely controlled through magnetic amplifiers.



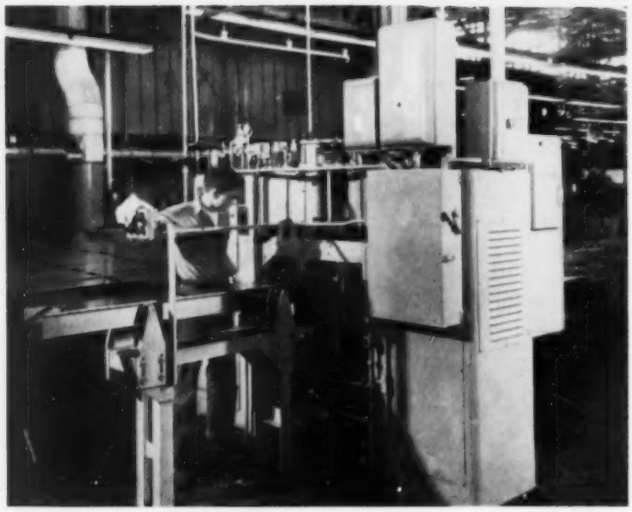


Figure 20 — Automatic bus duct welder was equipped with a static switching system in late 1954.

1955. It has now run over 10,000,000 operations, shows no signs of deterioration and has required substantially no maintenance. Figure 21 shows the control which operates this machine.

Shear line—Static control is in operation on a sheet steel shearing line. The material can be taken from either one of two reels.

There are two separate fully automatic operations that can be performed, either one of which can be selected by the operator. The first is like a conventional shearing operation. The material is fed from the roll into the shear for the desired length, it stops, the shear cuts off a length and then the cycle is repeated. The second selective automatic operation is more complex. The material is fed to a shear and the end trimmed. Next, it is carried back, stopped, moved over and fed to a second shear that cuts the piece off. This cycle is then repeated. All of the feeding and cutting operations are automatically sequenced and performed by magnetic logic units initiated from limit switches. Each operation may also be manually done for setup and checking by the operator using pushbuttons to initiate the logic.

Blast furnace loading—Static switching is being applied in a control which not only performs sequential blast furnace operations, but also provides for a highly flexible charging program.

The sequential operations include the following:

1. The upward and downward motions of the skip hoist.
2. Operation of the large bell, small bell, distributor and stockline recorder probes.
3. Operation of the automatic coke feeding mechanisms (conveyor, shaker and vibrating feeder).

Material supplied to the blast furnace includes water, coke, ore and various minerals. The ore and minerals are obtained and fed by a scale car controlled by a human operator. The water and coke are automatically fed.

When the requirement for coke is indicated by the programming setup, it will be automatically dumped into the skip when it next enters the pit. It will then be supplied either as two half loads from two weigh hoppers or as a full load from a single hopper. When water plus coke is required, the water will be put in the skip first. The gates will close when the hoppers are empty and the skip will then start to the top of the furnace.

When material from the scale car is needed, a signal will be sent to the operator of the scale car as soon as the skip enters the pit. The hopper gate will open provided the scale car is in the proper position for unloading over the pit. If water plus material is required the water will be put into the skip first, after which the signal permitting the scale car to be dumped, will be initiated. The operator will send the skip to the top after loading the skip.

This control is arranged so that extra charges of coke, water and other material can be loaded into the skip by manual operation. When skip is started automatically or manually, it will travel to the top, pause for a selected dumping period, and then automatically return to the pit. The dumping period will be controlled by two static timers. One timer is for all material other than ore. The other is to provide an increase in the dumping period when ore is being dumped.

As the skip leaves the top, it will initiate the distributor and small bell sequence. The small bell will operate without prior distributor motion when the angle selector counter indicates a zero distributor angle.

When the stockline recorder indicates that there is sufficient clearance between the material, the control will operate the large bell for dumping, immediately after the next small bell operation. If the stock line probes indicate insufficient clearance to dump the large bell, the next skip load of material will be delayed until the load has settled.

This system does not require a skip hoist operator to actuate the loading, unloading or movements of the skip. Only one man is required to operate all furnace loading including the operation of the scale car.

Tinplate packaging line—Static switching is being applied to automatically sequence and supervise all the transfer, weighing, wrapping and packaging devices to prepare palletized tinplate for shipment.

Tinplate is transported from the shear lines to the packaging line on pallets by fork trucks. These trucks place the tinplate on the entry conveyor and static switching performs all the operations from this point. It next transfers and positions the pallet on to the bundling line. Each palletized tinplate bundle is wrapped with protective paper, then covered with a paper carton. It is then banded by steel strapping, weighed and transferred to a shipping conveyor. There it is stacked, either 1, 2 or 3 high, as desired. The bundle is ready for shipping.

Hydraulic accumulator—An hydraulic accumulator is a storage vessel for water or any hydraulic fluid, the fluid under pressure, to be later supplied to the system to operate machines. Static control is being built for this application.

Three pumps are run continuously, loaded and unloaded by means of by-pass valves. The accumulator is pneumatic and its water level is gaged by means of a stainless steel tube connected at the top and the bottom of the vessel. An aluminum float containing a soft iron slug rides the surface of the water in the tube.

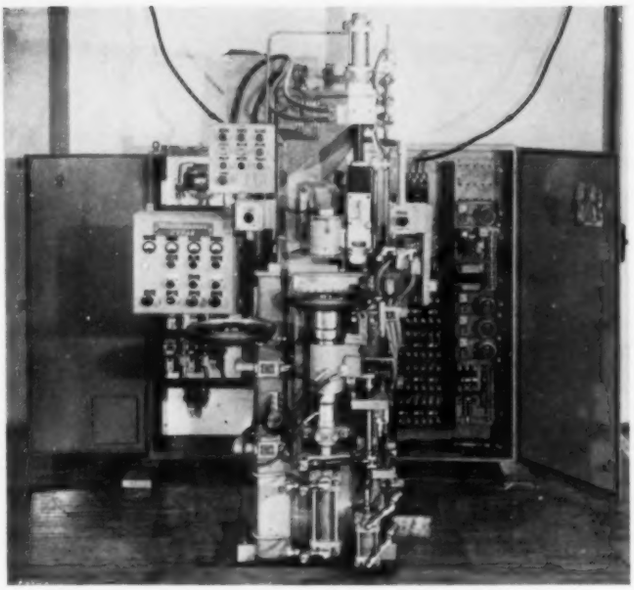


Figure 21 — Static switching, used on the torus vane loader, has run over 10,000,000 operations with practically no maintenance.

The signals to load and unload the pumps for feeding the system are obtained from this soft iron slug. This slug changes the inductance in a bridge circuit to balance the bridge which removes the output voltage.

As the fluid in the accumulator reaches certain increasing levels, by-pass valves are opened around the pumps to allow them to run idle. When the accumulator is full, all pumps are running idle. The order of rotation of the pumps can be changed by the pump sequence selector switch. Decreasing levels of fluid in the vessel will start the first, then the second, then the third pump to supply water.

If the system requires more fluid than the three pumps and the accumulator can supply, a low level valve is closed so the accumulator can be refilled and an alarm is sounded throughout the plant. The alarm indicates low pressure, and possibly shutting down unused machinery, or easing up operations for a short period, could correct this condition.

The logic device is used to program the pumps. By changing the 3-position selector switch, the pumps may be run in any sequence: (1, 2, 3); (2, 3, 1); (3, 1, 2).

The logic is also used to open and close the by-pass valves for each pump circuit. Logic circuits are set up so that signals from one bridge circuit to turn on a pump in the decreasing level condition will not again turn on the pump in the increasing level sequence.

This complete scheme from input signal to output is contactless.

Limit switches—At the present time, the mechanical limit switch finds wide use in the steel industry to detect the presence (or absence) of the material in the mill. The contacts of the limit switch are then used to control other functions, such as shears, positioning equipment, transfer equipment and other control functions. These mechanical devices are often undesirable because of their inherent tendency to wear and give trouble under the severe environmental conditions of heat, dirt, vibration and shock.

An ideal limit switch for this application, therefore, should not be actuated by contact with the metal itself. The actuating device should be located out of the way of possible damage by the metal. It is also desirable to have no moving parts. A device, initiated by the abundant infrared radiation emitted from hot metal, will often fulfill these requirements quite closely.

In an effort to develop such a device, many circuits and photocells have been tested. Briefly, it was found that simple series or bridge (photocell-relay) circuits are impractical because of possible relay chatter with slowly varying signals. Also, the sensitive relay which is necessary is mechanically undesirable for heavy duty steel mill service.

The devices desired, now referred to as a hot metal detector, to be suitable for rugged steel mill service, should incorporate the following characteristics:

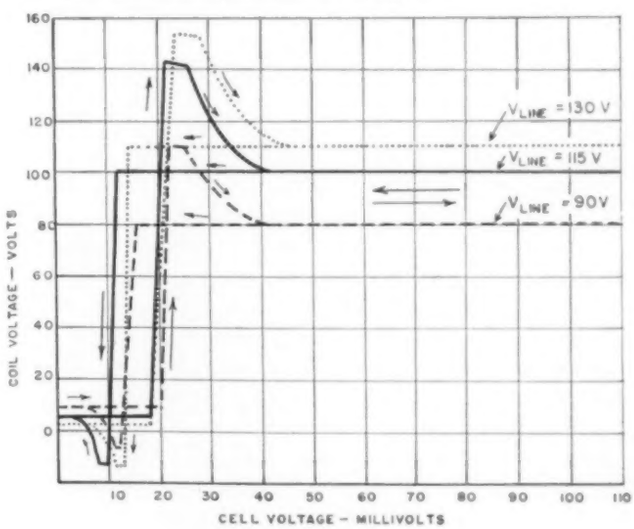
1. Must detect steel at temperatures from 800 F to melting.
2. Pickup head and photocell should be capable of operating in ambient temperatures as high as 100 C.
3. Distance between pickup head and amplifier; 300 to 500 feet, possibly as much as 1000 feet.
4. Distance from steel to pickup head: 2 to 20 feet (depends on application).

In addition, it is almost necessary to have a bistable output to the relay coil. This provides definite switch action and eliminates any possibility of relay chatter.

Development work carried on to determine a satisfactory infrared detector has indicated that germanium phototransistors or lead sulphide cells would be unsuitable for this use. A recently developed silicon solar battery exhibits favorable characteristics. This device consists of a large area silicon P-N junction which converts radiant energy directly into electrical energy. Tests indicated that the cell would be operated at an ambient temperature of 100 C, although the output is reduced somewhat at this temperature.

A second satisfactory detector is a cadmium selenide cell. This cell is very different from the solar cell, being essentially a variable resistance, the value of

Figure 22 — Cell input voltages versus relay coil voltage are shown for various line voltages.



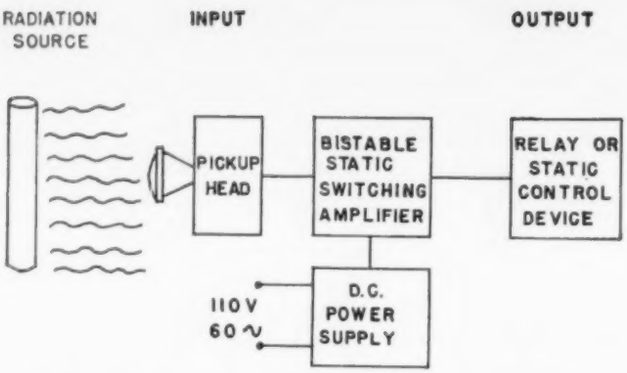


Figure 23 — Block diagram of hot metal detector.

which is proportional to the level of the incident radiation. This cell should not be used in ambient conditions over 75 C.

In order to increase the power level sufficiently to operate a relay and eliminate possibility of relay chatter, a bistable amplifier is needed. This has been done using transistors in a static switching circuit. It gives a fast acting, input level sensing, bistable output obtained by modifying a simple flip-flop circuit. It is not usually possible to obtain fast-switching-action for a slowly-varying-input signal with an ordinary type of flip-flop circuit.

A curve of cell input voltage vs. relay coil voltage is plotted in Figure 22. The bistable character of the output is readily noticed. The effect of supply voltage variations is also indicated.

The life of the complete device will probably be limited by the life of the relay. Transistors are predicted to have a long life. However, insufficient time has elapsed since their development to substantiate this claim.

The block diagram, Figure 23, shows the complete hot metal detector. Figure 24 shows the first production assembly of the amplifier, and Figure 25, the pickup head.

Early models were applied in a pipe mill for centering billets and operated satisfactorily at a temperature above 1500 F. In another application, operation was from a 27-in. wide strip at about 1900 F at a distance of 20 feet.

The solar cell meets the operating temperature requirements but delivers only a small signal. It is not sufficiently sensitive to infrared to be used for steel temperatures below 1500 F. The cadmium selenide cell temperature should be limited to 75 C; however, it delivers a much greater signal and is more sensitive to infrared. Minimum steel temperature for actuating this cell is about 1300 F.

A completely static device (no relay) which provides a definite on-off output, can be used when applied in conjunction with other static switching.

The solar cell and cadmium selenide cell actuated hot metal detectors, which have been described, are suitable for many steel mill applications. Steel temperature and exceedingly bad environmental conditions, such as steam, will probably place a natural restriction on some applications.

Another type of switch is available for use in static switching circuits. This new switch, the "proximity" switch, has no moving parts or contacts and, moreover,

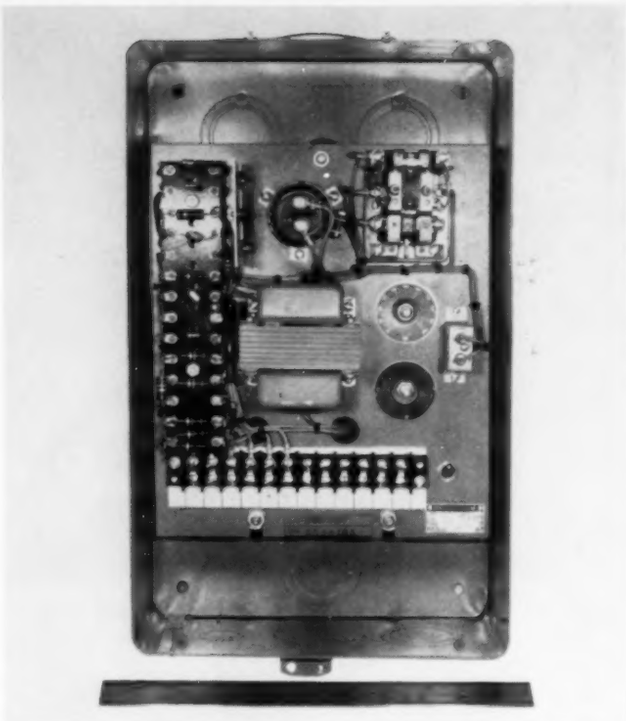


Figure 24 — Control used on hot metal detector.

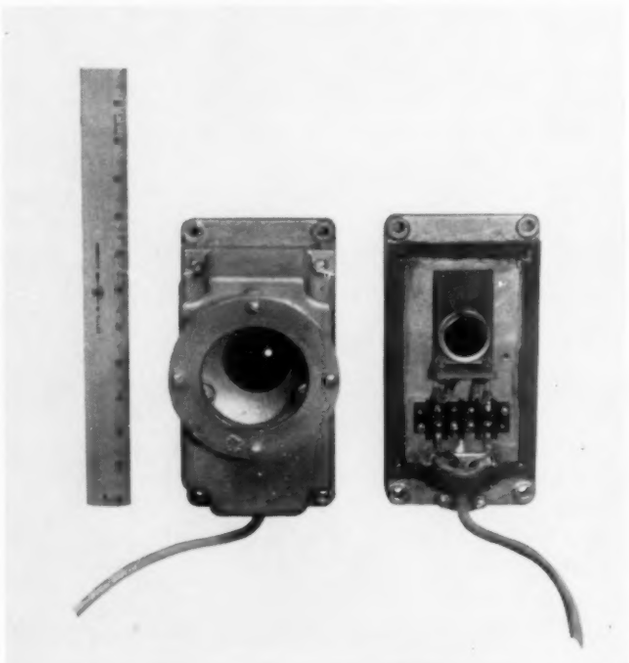


Figure 25 — Pickup head of hot metal detector incorporates a photocell.

is completely encapsulated. The proximity switch makes use of the change in impedance that occurs when a saturated core becomes unsaturated. Normally, a permanent magnet saturates the core, but when a small steel bar approaches, flux is shunted away from the coil assembly. The resulting change in impedance is sufficient to provide a change in signal capable of operating static switching control elements.

The basic proximity switch is limited to a maximum of about $\frac{1}{8}$-in. clearance between the operating steel bar and the operating face of the switch. In another limit switch assembly, the same principle and parts are

embodied in a rugged enclosing case with an external operating lever. This allows more leeway in operation, as the lever can cover a wide range of clearance and application conditions. Although this has the old disadvantage of an operating lever and bearing, it is a big improvement, as there are no contacts. After the bearings do become worn out, the complete operating arm, bearing and cover, can be quickly and easily replaced as a unit without disturbing the proximity switch parts, wiring or case. After replacement of the cover and lever, the switch is as good as new.

Servicing—The knowledge requirement for servicing is well within the capabilities of the average electrician. All that is necessary is that the electrician should be able to read a logic diagram. This ability comes readily with experience. It is not necessary that the electrician have an understanding of the inner workings of the logic elements.

The instruments required for servicing also fall within modest limits, since the only equipment absolutely necessary is a volt-ohm-milliammeter; or, to make testing more rapid and simple, a recently developed phase tester is not available. This phase tester consists of two small instruments in a single case, which are so designed that they can distinguish between the A and C phases shown in Figure 26. These instruments are adequate for all servicing requirements; but if wave shapes are desired, an oscilloscope can be employed.

Checking a control system to locate trouble is very similar to the location of trouble in a conventional relay control circuit. The first step is to isolate the problem by determining which of the various machine functions or operations is not performing as it should. Once this is established, reference to the logic diagram then reveals what portion of the circuit must be checked. The next step is to trace through this portion of the circuit, from point to point, to determine whether or not the input and output for each circuit element are correct. Proper inputs and outputs, as they are indicated by the instruments mentioned earlier, are shown in Figure 26.

SYMBOL	ELEMENT	OSILLOSCOPE	MULTIMETER	CYPAK METER
	OUTPUT AMPLIFIER		115 V(RMS)	NOT USED
	PRE-AMPLIFIER		12 V(AVE) D.C.	
A	AND	a OR c	6V (AVE) D.C.	
N	NOT	a OR c	6V (AVE) D.C.	
M	MEMORY	a INPUT a OUTPUT a; c INPUT a OUTPUT a; WITH INPUTS a & c OUTPUT = a	6V (AVE) D.C.	
	OR	ALL AC INPUTS WILL GIVE ½ WAVE D.C. OUTPUTS HAVING SAME PHASE AS POSITIVE PULSE	6 TO 12 V (AVE) D.C.	

Figure 26 — Symbols used in static switching diagrams.

Schematic and wiring diagrams—In making schematic and wiring diagrams for static switching systems, the

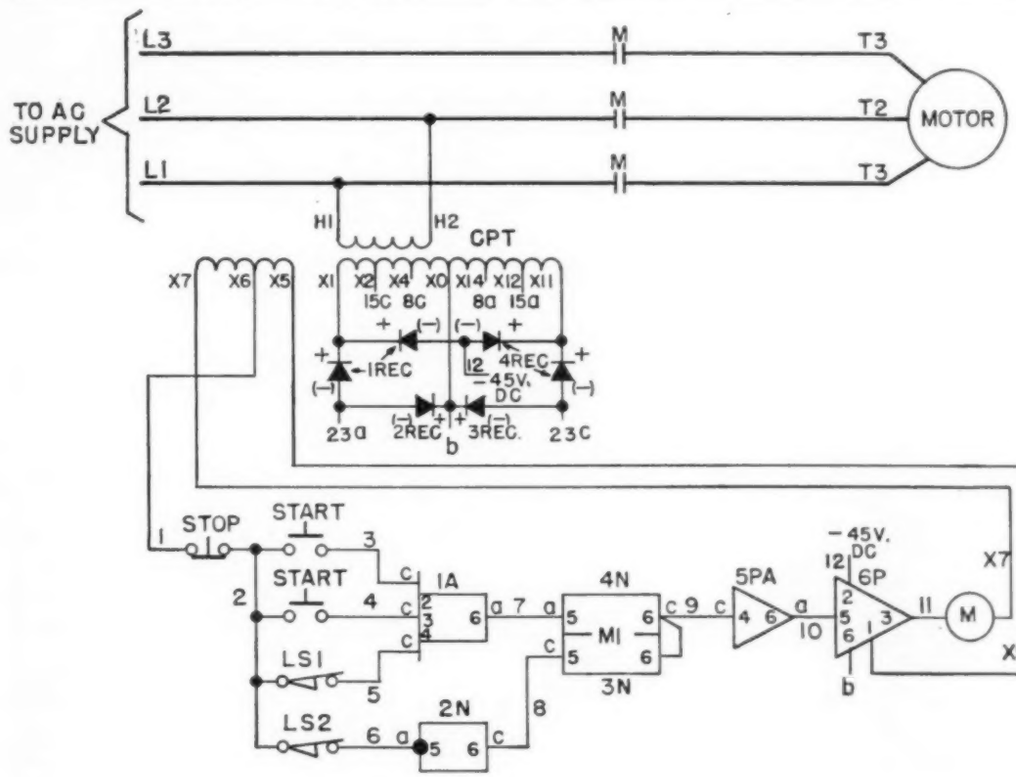


Figure 27 — Elementary control diagram for shear using logic functions.

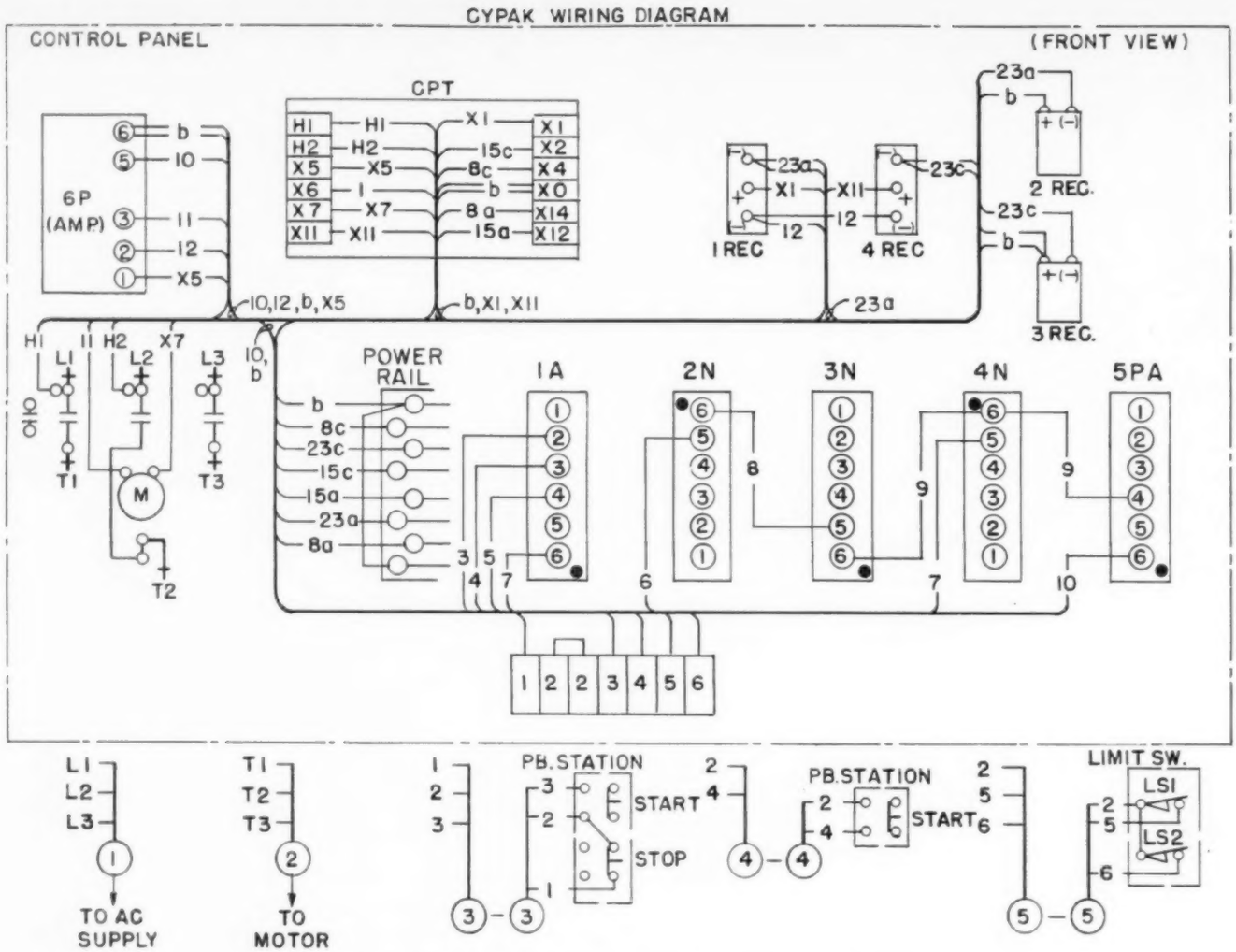


Figure 28 — Simple wiring diagram for shear using logic functions.

present industrial control practice for relay systems is followed as closely as possible. The diagram symbols are the same as those shown when previously explaining the basic functions. Once the function of each element is understood, reading a schematic is no more difficult than reading a conventional relay schematic. A simple example of this would be a manually controlled shear which makes a single stroke and has no special safety features. With the shear at the top of the stroke, it is necessary that one limit switch be closed to indicate that the shear is up. If it is desired to have two pushbuttons that must also be closed, then all three of these must give a signal to start the shear down. These two pushbuttons and a limit switch must then feed simultaneously into a three input *AND*. If the *AND* feeds into a memory circuit to turn it on, it will give an output and the pushbuttons can be released and limit switch contacts can be opened and the shear will continue down, cut and return. When the shear is almost up, another limit switch can be used to put an "off" signal on the memory circuit and the shear will stop at the top of the stroke. Figure 27 shows this logic diagram. Logic diagrams are always made to read from left to right whenever possible.

Static modules plug into a power bus at the rear. The wiring drawing shows them as rectangles. These are numbered. In addition to a number, each one has a letter designating its function, such as *N* for *NOT*, *E* for *OR*, *M* for *MEMORY* and A for *AND*. This provides a logic wiring diagram, as shown in Figure 28. The Industrial Control Section of NEMA is not working on standards for definitions and symbols to be used in static switching which are expected to be available by the end of 1957.

Automatic reversing roughing mill—Our company has recently developed an entirely new industrial drive concept and it is now being used for steel mill applications. Based entirely on the principle of the digital techniques of control, the system is predicated on the fact that the operation of a system, or a combination of systems, into a co-ordinated or integrated operation requires a vast amount of information handling.

The operation of the system can be described as:

1. Receives command intelligence from punched cards or tape.
2. Receives process intelligence from various devices.
3. Processes the information in 1 and 2 by digital-type logic functions, using static components.
4. Produces output signals to operate final output devices.

The first installation of this system will be programming of the complete rolling operation of a reversing roughing mill from punched card information. In

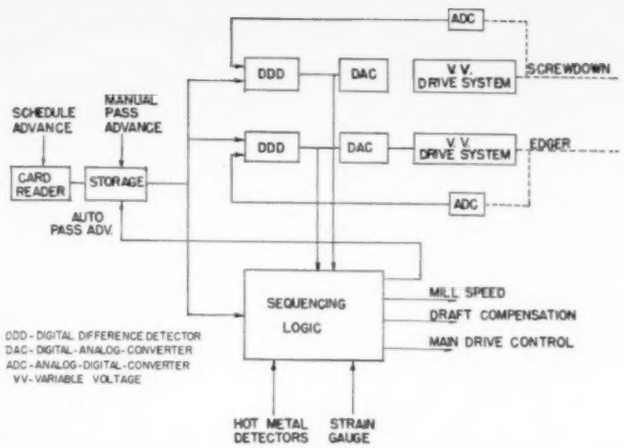


Figure 29 — Block diagram for automatic reversing roughing mill.

the rolling operation, several "passes" make up the "schedule" for rolling a slab (Figure 30).

For this mill, the following automatic functions are required from the control:

1. Setting the roll opening of the horizontal rolls (screwdown).
2. Setting the roll opening of the vertical rolls (edger).
3. Selection of one of six mill speeds.
4. Selection of one of nine draft compensations.
5. Controlling the main drive in starting, slowing down, stopping and reversing.

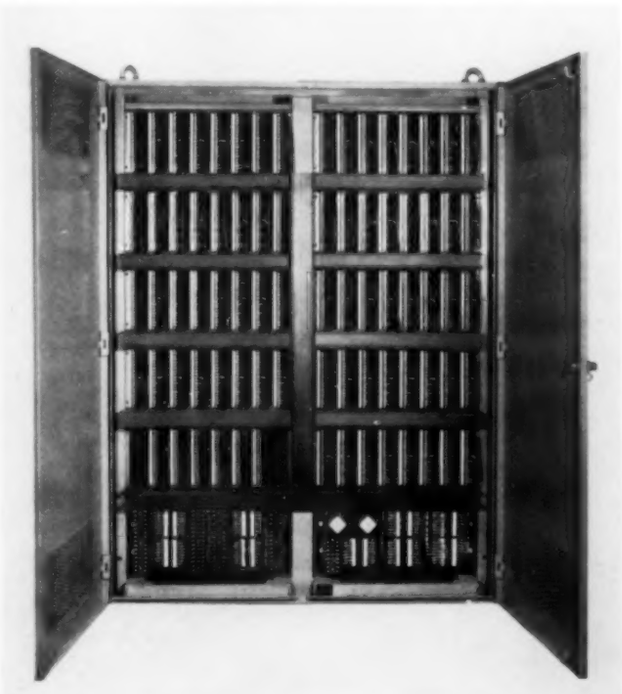
All pertinent data for a schedule is punched in a standard punch card and the above functions are then properly sequenced to automatically roll a complete slab without operator intervention. Figure 29 shows in block diagram form the basic functions of the control.

The operator sets up the mill by reading a card with the schedule advance pushbutton. He then starts the mill through its cycle by operating the pass advance pushbutton. Speeds and draft compensations are set up and the horizontal and vertical rolls start positioning to their programmed position for the first pass. As soon as these positions are reached, intelligence is received to start the mill in the proper direction. As the end of the slab is sensed by the hot metal detector located about ten feet from roll bits, slowdown is initiated. When the slab leaves the mill, the strain gage stops the mill and automatically operates pass advance to start the second pass. Every pass proceeds in this manner for the complete schedule.

By proper preparation of the process data in the punched cards, each schedule should run at its maximum efficiency. The control precisely follows the dictates of the card. Thus, the mill always runs at its maximum efficiency. It is not affected by the human traits of tiredness and the operator does not need to have the ability and experience that is generally required for manual operation of a rolling mill.

The justification for this relatively complex automatic mill is based entirely on an increase in quality production by consistent and accurate control of the mill at optimum efficiency.

Figure 30 — Control for automatic reversing roughing mill.



DISCUSSION

PRESENTED BY

A. W. SCHMITZ, Manager, Equipment Engineering, Industry Control, General Electric Co., Roanoke, Va.

T. H. BLOODWORTH, Supervisory Engineer, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

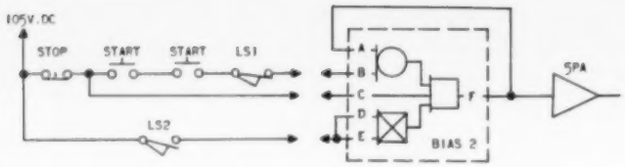
D. L. PIERCE, Assistant Manager, Control Dept., Motor and Control Div., Westinghouse Electric Corp., Buffalo, N. Y.

A. W. Schmitz: The author covers in detail the operation of logic switching and in addition gives a description of his company's development of a hot metal detector, a proximity switch, and a programmed control for a reversing roughing mill.

There appears to be some difference in the use of the term "static switching." The author seems to consider static switching as all inclusive— as the paper indicates. Our company refers to static switching as one of the components in an industrial control system. We both agree that static switching is a reliable new tool for logic functions and for switching signals performed in the past by relay contacts. To preserve space, these comments will be restricted to static switching referred to as component only. However, our company has also developed hot metal detectors, proximity switches and a variety of data processing control and programming control for a number of different types of steel mill drives.

This paper raised several questions in my mind. I would like to comment on these briefly:

1. *The future of conventional relays*—We feel that static switching provides more reliable control where frequency of operation or environmental conditions causes maintenance problems with conventional relays.



LS1- CLOSES ONLY AT TOP OF STROKE.
LS2- CLOSES APPROACHING TOP OF STROKE, OPEN AT TOP.

Figure 31 — Schematic shows how one multifunction static switching unit can be used to replace four logic units shown in Figure 27. This system can also provide temporary or permanent memory without additional logic units. Push buttons and limit switches are connected 105-volt-d-c voltage circuit. Each input signal is stepped down to 6 volts by resistor voltage divider.

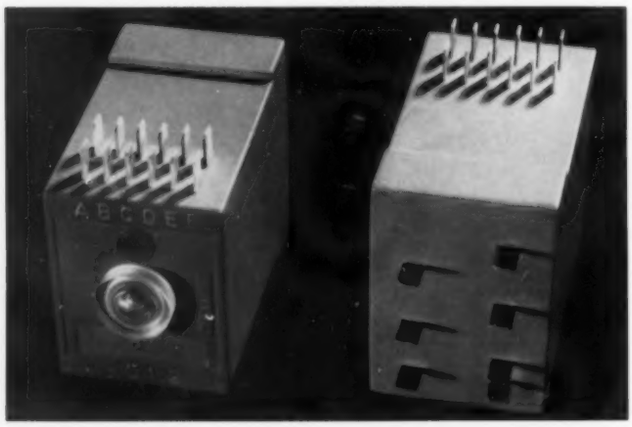


Figure 32 — Multifunction static switching logic units shown here are about 3½ in. deep x 2½ in. high x 2 in. wide.

At the same time we feel that there are many applications and functions which can be provided equally well with relays, and sometimes at lower cost. There is a need for both static switching and industrial relays in the steel industry.

2. *The problem of building fail safe static switching circuits*—We feel that static switching systems with properly designed logic units and control circuits can provide the same or better protection against misoperation than can be obtained with relays. We have designed our units with this feature in mind, and do not consider fail safe requirements a unique problem with static switching.

3. *Special maintenance problems*—The author has pointed out that input and output voltages of his logic unit must be of different phasing. This would seem to require extra units in some cases to provide the proper phase relation between the several inputs and to a multiple input *AND* or *OR* unit. The problem of determining phase relation between signals during maintenance of trouble shooting has apparently been simplified by development of a special phase tester. In our static switching system all signals are full wave d-c of the same magnitude, phase and polarity. The output of any unit may drive any other unit and may even be fed back to its own input to provide a seal-in function. A monitor light built in each magnetic unit eliminates the need of any instrument for normal maintenance. A standard voltmeter can be used to read voltage magnitudes, if desired.

Our company is very actively engaged in applying static switching systems to a variety of industrial drives. The static switching unit designed for the steel industry is a multi-function unit. This type unit has several input terminals. These may be connected to provide several logic functions with a single unit. For example, Figure 31 illustrates how one of our static switching units would replace all four logic units as shown in the shear circuit, Figures 27 and 28. With different conbinations of inputs a great variety of single or combination logic functions may be provided with the same unit. This provides the flexibility needed on complex controls.

The physical size of our multi-function unit is 2½ in. high, 2 in. wide, and 3½ in. deep. It is encapsulated as shown in Figure 32. It has stab-on connections to permit easy removal. This provides maximum flexibility for quick changes. The unit is rugged and does not easily damage. It was designed for steel mill service.

Eight such units make up a family. Each unit has its own color for the purpose of identification. Five of the family of eight use B1-stable magnetic cores—meaning it is either "On" or "Off" and is externally controlled. A monitor light gives visual indication whether it is "On" or "Off." The remaining three units serve as auxiliary devices and do not employ B1-stable magnetic cores.

The usual control features can be designed into the control system such as: magnetic time-delay, capacitor time-delay, permanent or temporary memory.

Static switching has been and is being applied to the following steel mill applications:

1. A master control for a tandem cold strip mill.
2. A master sequencing (repeat cycles) control for a slabbing mill, edger, and mill auxiliaries.
3. A master sequencing (repeat cycles) control for a blooming mill.
4. A transfer control for a sintering plant.
5. Currently, we have a number of active propositions that will include static switching.

Finally, steel mill type systems require flexibility since frequent advances are made in operation methods. Our multi-function units often allow considerable modification of control without adding additional units.

T. H. Bloodworth: Static switching will play an important part in steel mill control, particularly in increasing reliability with reduced maintenance. I wish to stress this point, improvement of reliability with reduced maintenance. Equal reliability can be obtained with contacting devices in most cases, but only with good preventive maintenance, that is, replacement of parts and components long before their life expectance is approached.

Mr. Pierce has stated that a check on the application of many magnetic amplifier installations did not disclose a single failure, or case of trouble, or evidence of any maintenance. We will, however, have failures in such systems, even though the number of such failures is small compared to that encountered in other systems. There will be failures due to defective components which escape all factory testing, failures caused by overloading, either voltage or current, due to failures of some element external to the magnetic amplifier control, and finally, to maladjustment of some exterior component.

Mr. Pierce has described and given illustrations of one approach to the static switch problem for steel mill applications. This is the use of an industrial logic element as a control component. An alternate method is the use of components containing combinations of logic elements.

As Mr. Pierce points out, static switching requires more components than a comparable control using multi-contact relays. Because of this, the manufacturing costs of static switching systems today is higher than that of the contact type controls in nearly every case. Therefore, good judgment must be used in the selection of control situations requiring static switching. These normally are:

1. High operational frequency.
2. Location—corrosive or hazardous atmosphere.
3. Low voltage applications or applications requiring sensitive relays.

Mr. Pierce's paper described static switching of digital type. We have used static control of interlock type for over 15 years to control motor operation, not only direction of rotation but also speed of rotation, in response to external signals. Such controls do not require the special power supplies necessary for the digital contactless switching. Only recently have magnetic materials been developed to make digital switching possible.

D. L. Pierce: Mr. Bloodworth in his comments stated "As Mr. Pierce points out, static switching requires more components than a comparable control using multi-contact relays. Because of this, the manufacturing costs of static switching systems today is higher than that of the contact type controls in nearly every case."

Static switching sometimes requires more components than relays but this is not always true. In some cases it may take less. The number of components required are a factor in the cost but there are other important things which also affect the cost.

On the problem of building fail safe static switching circuits, I believe what Mr. Schmitz says concerning better protection against misoperation with static switching is true. I did not intend to imply that as good protection could not be obtained, but merely to caution those familiar with relay circuits that doing logic circuits similar to relay circuits may not give protection. Consequently, this problem must be given careful consideration in designing logic circuits.

Mr. Schmitz states that the input-output phase on the logic being different would seem to require extra units in some cases. This can be occasionally true but usually the logic will work out such that extra units are not required. Occasionally this can be used to advantage.

The phase tester for determining phase of an output is usually more of a design check tool than a servicing tool. For indication of circuit continuity and to aid servicing, usually small indicating instruments (1½-in. diam) or pilot lights are permanently mounted and wired in the circuits.

Mr. Schmitz in his comments advocates the use of multifunction units. There are some advantages in combining static switching logic functions in a single block. This is done to some extent where it was felt that there would be over-all economic advantages. A system using multi-function units is more difficult to design and less easily interpreted by maintenance. The shear diagrams shown in Figure 27 and Figure 28 are not actually the way we would build this control but were created to illustrate the principle of static logic and for clarity of understanding.

1958 AISE

WESTERN MEETING

HOTEL STATLER

LOS ANGELES, CALIF.

February 24, 25, 26

CURRENT AISE DISTRICT SECTION MEETING NOTICES

BIRMINGHAM SECTION

Friday, December 13, 1957
Christmas Dinner and Dance
Dinner 6:30 P.M.
Dance 9:00 P.M.
Thomas Jefferson Hotel, Birmingham, Ala.

BUFFALO SECTION

Saturday, December 7, 1957
Christmas Dinner and Dance 7:30 P.M.
Hotel Statler, Buffalo, N. Y.

CHICAGO SECTION

Saturday, December 7, 1957
Christmas Dinner and Dance
Dinner 6:30 P.M.
Palmer House, Chicago, Ill.

CLEVELAND SECTION AND YOUNGSTOWN SECTION

Saturday, December 7, 1957
Christmas Dinner and Dance
Dinner 7:00 P.M.
Rainbow Room, Hotel Carter, Cleveland, Ohio

DETROIT SECTION

Saturday, December 7, 1957
Christmas Dinner and Dance
Social Hour 7:00 P.M.
Dinner 8:00 P.M.
Detroit Yacht Club, Belle Isle, Detroit, Mich.

LOS ANGELES SECTION

Friday, November 22, 1957
Dinner and Dance
Social Hour 7:30 P.M.
Dinner 8:30 P.M.
Dancing until 1:30 A.M.
Candlewood Country Club, South Whittier, Calif.

PHILADELPHIA SECTION

Saturday, December 7, 1957—Dinner 6:00 P.M., Meeting 7:00 P.M.

"Operational Features of 45-In. Slab Mill 80-In. Hot Strip Mill at Fairless Works," by T. D. Clifford, Superintendent, 45-In. and 80-In. Mills, United States Steel Corp., Fairless Works, Fairless Hill, Pa.

"Evaluation of Soaking Pit Requirements for Expansion Program," by George J. Meng, Industrial Engineer, Alan Wood Steel Co., Conshohocken, Pa.

Engineers' Club, 1317 Spruce Street, Philadelphia, Pa.

PITTSBURGH SECTION

Saturday, December 14, 1957
Christmas Dinner and Dance
Dinner 8:00 P.M.
Dance 9:30 P.M.
Penn-Sheraton Hotel, Pittsburgh, Pa.

ST. LOUIS SECTION

Saturday, December 14, 1957
Christmas Dinner and Dance
Dinner 7:00 P.M.
Dance 9:00 P.M.
Mineral Springs Hotel, Alton, Ill.

SAN FRANCISCO SECTION

Saturday, December 14, 1957
Christmas Party
Mt. Diablo Country Club, Danville, Calif.

UTAH SECTION

Wednesday, December 18, 1957
Christmas Party
Salt Lake City Country Club, Salt Lake City, Utah

Bottoms for Basic Open Hearth Furnaces

By STEPHEN WORTMAN
Open Hearth Superintendent
Judson Steel Corp.
Emeryville, Calif.

. . . . progress in open hearth production will follow lines such as: fast installation of relatively inexpensive bottoms, improved drainage of the hearth, better fettling materials and adoption of some European practices . . . .

▲ THE open hearth furnace although almost 100 years old is still going strong in spite of growing competition from the electric furnace. There have been no revolutionary changes in principle or general design of the furnace during the relatively long history of open hearth steelmaking, but progress in science and engineering has brought remarkable improvements in the construction of all parts of the furnace from the foundations to the roof.

Of all parts of the open hearth furnace the bottom is the most expensive to build and the most difficult to maintain in trouble-free condition. Owing to the high initial cost of the time consuming installation of a new bottom, the replacements of bottom are avoided or at least postponed sometimes far beyond the point of diminishing return.

In the past there was nothing unusual in an open hearth bottom 20 or 25 years old, and even quite recently one steel plant on the West Coast replaced a bottom after 33 years of service. The time factor involved in sintering of a magnesite bottom used to cause considerable production losses while modern methods may reduce the installation time of a new open hearth bottom from a few weeks to a few days including heating-up period.

With steel in demand, shorter but trouble-free bottom life is preferred to a long life with very frequent and costly delays for repairs. Therefore, the recent trend is a fast installation of a relatively inexpensive type of bottom which is replaced every few years.

Another factor in favor of more frequent bottom replacements is the recovery of subhearth refractories, which in case of a very old bottom is practically negligible. Sometimes fifty per cent and more of valuable bricks can be salvaged from a bottom that has been in operation for five to eight years.

An old bottom is liable also to contaminate high alloy steel heats which sometimes may make the replacement of the bottom imperative.

All refractory materials that rest on the pan and on the chill plates up to the foreplate level belong actually to the bottom. Thus the lower portion of the banks should be considered an integral part of the bottom. Consequently the back, front and bridge walls start at the foreplate level and the banks proper are sintered or rammed refractory material protecting the brickwork of the bridge, front and backwalls.

Conventional construction of the bottom steelwork consists of longitudinal and transverse I-beams supporting chill boxes, front and backwall castings and buckstays, which in turn are the framework of the whole furnace upperstructure.

Longitudinal beams are usually 18 to 24-in. I-beams located on 16 to 24-in. centers. The number of the beams depends on the size and width of the furnace and on the construction of the foundations. Longitudinal I-beams are laid on ½ to 1-in. thick plate resting on top of the foundations.

Transverse beams are laid on top of the longitudinal beams usually on 16 to 24-in. centers. The size of these beams varies between 16 and 24 in. For connection with front and backwall buckstays and with all castings, channels of the same height as the transversal beams are used. They are of course longer than the adjacent transversal beams.

The shape and construction of the chillboxes depends on the furnace design. The main purpose of the chillboxes is to support the rising ends of the bottom and the bridgewall and to provide an adequate air cooling for the hottest spots of the bottom and of the banks.

Steel sheets can be laid loosely on the transverse I-beams and channels, but if riveted or bolted, all rivet and bolt projections should be covered with insulating or plastic material. The bottom steelwork is permanent

and usually remains unchanged throughout the whole life of the furnace.

There has been some controversy regarding the problem of insulation of the bottom. The insulation of the bottom will raise the thermal efficiency of the furnace, but it may cause creeping and flowing of fireclay refractories used for the construction of the lower portion of the subhearth. Therefore many open hearth bottoms have been built without any insulation whatever in order to avoid so-called "soft bottom." Soft bottom may cause more trouble than a noninsulated bottom which is exposed to cooling by air currents.

Many kinds of bottom insulation are used. Some older bottoms for example have the pan covered with a layer of diatomaceous earth bonded with tricalcium aluminate type cement. The diatomaceous earth is a porous product of fossil origin. It has a density of about 18 lb per cu ft, and is recommended for temperatures up to 1600 F.

Sometimes insulating bricks are used, one flat or even a rowlock course at the bottom. There are bottoms which have a layer of about 2 to 3½ in. of insulating cement poured directly on the plates of the pan. If no insulation is desired, a layer of chrome ore or finely ground ganister should be used; this layer should be thick enough to cover all projections on the pan, such as bolts and rivets. Castable or plastic refractories whenever applied solve the problem of leveling off almost perfectly.

All refractory materials which rest on the bottom steelwork are not only sporadically replaced, but very often the entire arrangement or construction is changed and different kinds of refractories are used.

The shape of the subhearth built out of bricks usually follows the stadium type pattern which may have few varieties. The simplest and least expensive subhearth is the stadium type with straight corners and with all fireclay and basic bricks laid dry. In this type of subhearth, 9-in. straights are vastly predominant with a small number of large straights used for breaking the joints. A stadium type subhearth with rounded corners is a little more expensive because keys are used to obtain round corners.

During the last few years, quite a few so-called inverted arch bottoms have been built. Basic castables are rammed in the shape of the desired contour of the tub, and the top layer of this kind of a subhearth is built of basic brick laid soldier fashion for maximum resistance to washing and floating out. The soldier course brick may be laid with full dipped joints of basic cement without any expansion joints; the subsequent shrinkage of the cement will allow for the required expansion.

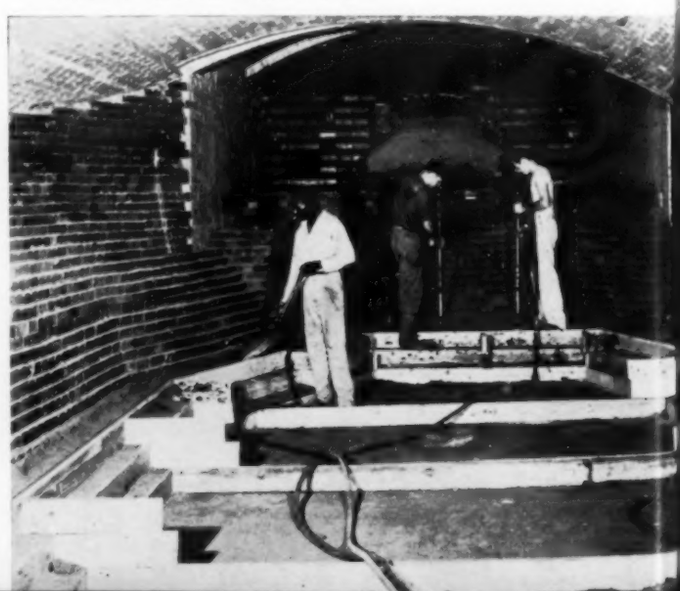
Some modern inverted arch bottoms have one rowlock course of chrome magnesite brick right under the top soldier course for which bricks with high magnesia content should be used. Also this rowlock course of chrome magnesite brick is laid with full dipped joints of basic cement. This kind of subhearth construction makes the bottom tight and relatively safe, which means that the subhearth alone should be capable of holding steel in case of deep holes in the hearth proper. For greater safety, hydraulic setting chrome mixture instead of castable fireclay refractories may be used. This kind of chrome ore is plastic and can be easily rammed to the desired contour.

Fireclay brick are used for the bottom courses of the conventional type of subhearth and they are laid dry on the insulation or directly on a thin layer of chrome ore covering the bolt or rivet projections. High duty fireclay bricks are especially suitable for the lowest courses of the bottom, because they have the strength and ability to sustain high pressures under conditions of soaking heat.

The fireclay bricks have relatively low thermal expansion and in most cases they are laid loosely enough to provide sufficient expansion space in the individual joints. The thermal conductivity of fireclay brick in the range of 1000 to 1200 F is about one third of the thermal conductivity of fire magnesite bricks in the same temperature range. This property helps to prevent high heat losses from the brick courses laid on top of fireclay courses. Fireclay bricks being the least expensive of all bottom refractories make a good and very economical fill in the corners all around the bottom. The only exception where fireclay brick should not be used is at the tap hole where, owing to the drainage slope, the bottom is thinnest. The usual method of building this portion of the subhearth is to replace the fireclay brick at the tap hole with magnesite or chrome magnesite bricks. This solid bank of basic brick is as thick as the fireclay course, and it is usually 6 to 12 ft wide on both sides of the tap hole. In the direction of the frontwall, the basic brick bank sometimes reaches as far as the middle of the furnace.

The thickness of the fireclay course varies, the most common being 3, 4½, 5½, 6 and 9 in. If 3 in. thickness is chosen, it indicates one flat course of the 3-in. series; 4½ in. means that the designer prefers a little tighter construction and uses one rowlock course; 5½ in. can be obtained by using one flat course of the 2½-in. series and one flat course of the 3-in. series. The 3-in. top course is required to match the adjacent chrome-magnesite or magnesite bricks. Quite a few American furnaces have very thick bottom brickwork with 11, 13 or 17 in. course of fireclay brick, there are even extreme cases where the thickness of the fireclay courses reaches 31½ and 35½ in. The fireclay bricks are usually laid all headers as a simpler and faster construction

Figure 1—Wooden forms are here used when ramming the bottom of a large furnace.



Sometimes preference is given to a little stronger construction by laying brick in alternate header and stretcher courses. With this latter kind of construction, it is easy to break the joints. The rule of breaking the joints can be observed also with the all header construction by using few large straights wherever necessary. Any straight through joints in the bottom brickwork should be strictly avoided to minimize the risk of a breakout.

It has been a general practice to use burned chrome magnesite bricks for the intermediate courses of a conventional type subhearth. In all chrome magnesite bricks, preburned magnesite and added chemical binders are blended with a certain amount of selected chromites.

In a chrome magnesite mixture, the chromite constituent is usually predominant by weight. Bricks of this type are available in two kinds:

1. Chemically bonded, formed on presses in steel dies under extremely heavy pressures. In general they are the most resistant of all basic refractories to the spalling effects caused by rapid changes in temperature.

2. Hard burned bricks which are fired at high temperatures in order to develop strong crystalline ground mass of fosterite as a bond for grains of chrome spinel, thus achieving greater strength and load carrying capacity at high temperatures than the chemically bonded bricks.

The chrome magnesite bricks may be laid dry with expansion joints from $\frac{1}{16}$ to $\frac{1}{8}$ in. per ft, obtained usually by inserting precut pieces of corrugated cardboard paper.

The chrome bearing refractories are sensitive to the attack of iron oxides which may occur in case of a deep penetration of slag or steel. Therefore whenever greater stability of the bottom is required, the chrome magnesite bricks may be omitted altogether in favor of thicker high magnesia top courses of the bottom brickwork.

The top courses of the subhearth usually consist entirely of magnesite bricks which contain 85 to 96 per cent of magnesia mainly in the form of crystals of the mineral periclase.

Nowadays there is a very distinct trend toward magnesite bricks with the highest possible magnesia content. Bricks of this kind are formed under high pressure to develop a density up to 172 lb per cu ft with a porosity frequently being less than 20 per cent. They are subsequently hard burned in oil or gas fired kilns to obtain maximum strength and freedom from shrinkage.

The resistance to thermal shock of the hard burned high magnesia bricks is rather low, but this is of no consequence since they are not heated up rapidly, and even if they crack they cannot fall out of their position.

The high magnesia refractories have the highest melting point of all refractories used in the open hearth furnace construction, and they also have great resistance to chemical attack by basic oxides such as iron oxides, lime and basic slags. They also are resistant to the action of the carbon monoxide. Over a very long period of time, magnesite bricks or grain magnesite change color and become almost white due to the reduction of magnesio-ferrite by carbon monoxide.

The iron oxides added or existing as an inherent component of the mixture, form magnesio-ferrite compound as one of the constituents of the bond.

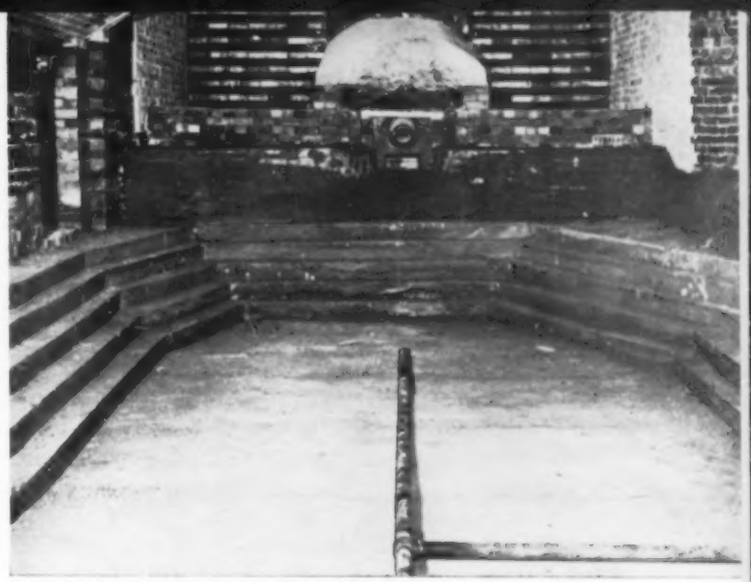


Figure 2 — Ramming of large furnace bottom has been completed and hearth burners are installed for light-up.

Magnesite bricks have the highest thermal conductivity of all open hearth refractories, which facilitates cooling of the hot working surfaces and results in longer life at a cost of considerable heat losses.

Water vapor has a detrimental effect on refractories containing periclase, lime and lime silicates which hydrate and disintegrate fairly easily. During periods of idleness or during furnace rebuilds, it might sometimes happen that a portion of the bottom accidentally becomes drenched with water from water-cooled door frames or other water-cooled equipment being replaced or repaired. Such portion of the bottom should be dried out and checked very carefully. If necessary the whole affected area should be removed and replaced by new bricks and cold rammed magnesia mix.

The top portion of the bottom upon which steel is made under normal condition is the hearth proper.

The most common types of hearth construction used in the basic open hearth furnaces are:

1. Dolomite bottoms, which may be put in as fully rammed, partially rammed or entirely fired.
2. Fired grain magnesite bottoms.
3. Special magnesia mixes bottoms, which may be fully or partially rammed.

Dolomite bottoms predominate in European practice. The usual European method is to ram a mixture of finely ground dead burned dolomite and tar on subhearth brickwork to a minimum thickness of 10 in. and maximum of 20 in. Shortly before ramming, the subhearth is covered with a layer of hot tar to facilitate good adherence of the ramming material to the magnesite bricks. Sometimes finely ground burned magnesite is added to the dolomite-tar mixture.

Tar used as a bonding agent for dolomite must be agglomerating and must produce a coke residue as large as possible and must have constant composition.

The relatively very low stability of this kind of a basic open hearth furnace bottom can be improved to a certain extent by using good quality dolomite with highest MgO and lowest Fe_2O_3 and Al_2O_3 content. Much better results are obtained not only in this, but in all applications with crystalline dolomite than with the amorphic variety. This is probably due to better

volume stability and lower impurities content of the crystalline dolomite.

Partially rammed dolomite bottoms have the dolomite and tar mixture rammed on the flat and on the banks, and grain dolomite burned-in on top of the rammed material. Double burned dolomite used for the purpose is mixed with 25 to 30 per cent of finely ground open hearth slag and layer upon layer is burned-in hard. Dead burned dolomite has a fast bonding rate and it does not take long to burn in a few inches on top of the rammed material. As soon as the desired thickness and shape is obtained, the furnace is charged full with clean open hearth slag to fill in all crevices and voids.

Some European steel plants obtain good results with bottoms introduced by Crespi, where finely ground dolomite is rammed very hard in thin layers without any binding media whatsoever. If properly installed, these bottoms have low porosity, are fairly homogenous and almost monolithic. Very often the first 100 to 120 heats of life of such a bottom are troublefree with no time lost for repairs.

Fired dolomite bottoms belong also to the European practice, although they are much less common than the fully or partially rammed dolomite bottoms. Dolomite bottoms are liable to disintegrate rapidly whenever there are conditions for hydration or carbonation of the lime constituent of the dolomite. The lime is easily extracted from the dolomite by low melting Fe_2O_3 and is soluble in the early slags which usually have low basicity. This of course makes the dolomite bottom much less stable than a magnesite bottom and causes more frequent and serious bottom troubles.

The dolomite bottoms are by far the least expensive, but owing to low stability they have not been adopted by the American practice.

Figure 3—Stadium type subhearths used in small furnaces.

In the United States in answer to a questionnaire forwarded to all member companies by the American Iron & Steel Institute in 1947, about 27 per cent of open hearth shops still preferred fired magnesite bottoms, but recently the trend toward fully or partially rammed bottoms seems to be more distinct.

There is not much doubt that a properly burned-in grain magnesite bottom would have very good performance and excellent stability, but sometimes it takes as long as three weeks before the furnace is ready for charging. On the other hand, it may take only three days to install a new rammed bottom including heating up of the furnace. This time factor is very much in favor of the rammed bottoms especially when high furnace availability is necessary to satisfy demand for steel.

Dead burned grain magnesite used for fired magnesite bottoms can be of natural or seawater origin. The process of manufacturing grain magnesite from natural deposits includes the following stages: mining of the magnesium carbonate rock, screening, upgrading by beneficiation, mixing with necessary amount of iron oxides and firing in rotary kilns.

In the process used in obtaining grain magnesite from seawater, magnesium chloride from seawater and high purity calcined dolomite are reacted. One of the products of that reaction is magnesium hydroxide which is blended with various sintering additives and fired in rotary kilns. This process seems to give a product of greater uniformity and density than that obtained from natural origin. However the rock magnesite can also give excellent results if burned in properly.

Relatively fast burning-in rate, good dense bottom, and sufficient angle of repose can be obtained by using grain size 4.2 mesh (screen No. 4) where the predominant size of grains is 0.187 in. Inasmuch as very fine particles may be of greater porosity and may lower the bulk density of the bottom, they should be screened out. Grain magnesite must be thoroughly mixed with open hearth slag, preferably in a cement mixer. The slag should be clean and finely ground. The amount of slag varies from 15 to 25 per cent depending upon manufacturer's instructions or previous experience with the same kind of magnesite.

For the burning-in of a magnesite bottom, the furnace must be brought to the normal operating temperature and highest possible temperatures should be maintained during the whole long process of sintering of the grain magnesite. The magnesite-slag mixture is shoveled in thinly all over the bottom and over the ends. Each batch should be heated until samples taken out of the furnace by means of a hook or a pipe show that the magnesite has burned-in hard. As soon as the desired thickness and shape of the bottom is obtained, the tap hole is burned-in, usually around a 6-in. pipe, and then the furnace should be charged full with clean open hearth slag. The bottom should be allowed to soak in the slag for a few hours in order to fill in all voids. It seems to be a good practice to chill the furnace for a short while after tapping the slag, provided the temperature jump is not too sudden to give the basic bricks a thermal shock which might cause spalling. The furnace is then ready for charging the first heat.

The density of a fired magnesite bottom is 190 to 220 lb per cu ft which is higher than the density of

any other kind of open hearth furnace bottom. High density of a fired magnesite bottom insures great resistance to the penetration of steel. A fired magnesite bottom, if properly burned in, will withstand the soaking action of the soft steels better than any other kind of basic open hearth bottoms. Nevertheless, the extremely long and costly process of burning-in, heavy production losses and sometimes lack of experienced men make it very doubtful whether the installation of a fired magnesite bottom is economically justified.

The right choice of magnesia mixes for fully rammed bottom is very important. A good ramming mix should have the highest possible MgO content, high packing density and low tendency to shrinkage and expansion during temperature changes. At the end of the heating up period, the rammed material should become a homogenous monolithic mass due to crystal bridging only and without any binding media. The density of a rammed bottom should be at least 175 lb per cu ft.

For the installation of a rammed bottom wooden forms or steel templates can be used; however, for large furnaces or steep banks the steel templates should be avoided.

Detailed instructions for the ramming procedure and heating-up are usually supplied by the manufacturer's representatives who should be present at least during the initial installation.

The time required for putting in a new fully rammed bottom depends mainly on the capacity of the furnace and on the type of equipment used. With proper equipment, a fully rammed bottom of a large furnace can be put in at a rate of 12 to 14 tons of ramming material per hour. As soon as the ramming is completed and the auxiliary equipment removed from the furnace, the hearth burners, if used, are installed and if it was not done before, the venting holes are punched or drilled. Perforating of the rammed material and slow careful heating according to the manufacturer's instruction are absolutely imperative. Lack of venting holes, or too fast heating, may result in peeling and breaking off of portions of the rammed bottom. In some cases the rammed bottom may start cracking and blowing up rather violently, and the whole job has to be done all over again with that much wasted time and material. After the furnace reaches normal operating temperature, it seems to be a good practice to hold the furnace at that temperature for a period of 24 hours before charging the first heat.

Unless a long time is allowed for burning-in, any grain refractory material with a slow sintering rate placed on top of the rammed bottom will float out to the slag, making the slag of the first heat very thick, inactive and dangerous to the roof. Therefore it seems to be useless to shovel in any fettling material very shortly before charging the first heat.

In 1947, fifty-five per cent of all open hearth shops questioned by the American Iron & Steel Institute preferred partially rammed bottoms, giving the following reasons:

1. Bottom boils stop at the rammed subhearth.
2. Installation can be made in a short time.
3. Savings in burning-in time compared to the fired-magnesite bottom.
4. Minimum cost.
5. Better resistance to the penetration of steel than that of the fully rammed bottom.
6. The magnesite sintered on top of the rammed bottom closes any cracks that develop in the rammed portion of the bottom.
7. Excellent service with minimum repair time.
8. Experience that the partially rammed bottom was best.
9. Reduced possibilities of hydration during shutdowns.
10. Combination of good features of a fully rammed bottom and good qualities of the sintered magnesite bottom.

There seems to be little doubt that partially rammed bottoms have greater stability than fully rammed bottoms, and the extra few days required for burning-in grain magnesite on top of the rammed material may result in better performance and longer troublefree life of the bottom. However the appearance on the market of better quality ramming mixes may cause a shift of opinion in favor of the fully rammed bottom.

The total thickness of American open hearth furnace bottoms usually varies from 17 to 53 in. and there seems to be a tendency to build thicker bottoms for larger furnaces, while in Russia, for example, the thickness of the bottoms for medium and large furnaces are about the same. In Great Britain and in Germany, the bottoms are generally built thinner than in the United States.

Regardless of the type, the finished bottom should have a very good and fast drainage from all directions toward the tap hole. The slope of the banks may be about $\frac{1}{8}$ and $\frac{3}{8}$ in. per foot which is a little milder slope than the angle of repose of the refractory materials used for fettling, and the slope of the so-called "flat" should be a minimum of about one in. per foot. Sharper slopes (up to $1\frac{1}{2}$ in./ft) can help to obtain longer and relatively troublefree life of the bottom. In case of larger furnaces, too sharp a slope could make the bath too shallow at the ends which would lower the capacity of the furnace. Therefore large furnaces often have bottoms with milder slopes, the most common being $\frac{3}{8}$, $\frac{1}{2}$ or $\frac{5}{8}$ in./ft.

However, any kind of open hearth furnace bottom has a tendency to wear off at the hottest spots, which are at the ends, and this process can be retarded by providing a sharp slope for fast drainage and by making the bottom much thicker at the ends. As long as the bottom can be drained fast and clean, there is little danger of any trouble. Bottom troubles usually start when the ends become lower than the middle portion leaving undrained pools of slag or steel.

Inasmuch as the bottom and the banks work in very rough conditions, they require constant careful maintenance. Any carelessness may cause costly damage and heavy production losses.

A great deal of bank and bottom troubles can be prevented by meticulous inspection of scrap and by careful charging. Any contamination of scrap, such as lead, aluminum, nonferrous alloys, sand, dirt or bricks often found in drums and bales, can cause serious bank and bottom troubles. Mechanical damage can result from careless charging, especially from dumping heavy scrap directly on the bottom, or from pushing scrap hard against the banks. New fully rammed bot-

toms seem to be much more susceptible to mechanical damage during charging than the fired or partially rammed bottoms. Light, choice scrap should be used to protect the bottom for the first few heats. In hot metal shops, new fully rammed bottoms will also give better and longer service if cold pig iron is used for the first few heats instead of hot metal.

In the United States time for fettling and bottom and bank repairs is distributed per heat and it depends upon many factors, the most important being the furnace capacity. Under similar conditions the approximate average time lost for fettling, bottom, banks and tap hole repairs is:

Furnace capacity, tons	*Bottom, banks and tap hole maintenance and repairs, min/heat*
Up to 100	50
100 to 150	64
150 to 200	66
200 to 250	68
250 and more	70

Deviations from the above figures can be caused in individual shops by:

a. The type, age and condition of the bottom.
b. The number of low carbon heats made.
c. The quality of scrap.
d. Amount and chemical composition of hot metal.
e. Quality of fettling materials.
f. Local repair practice.

The usual American method of fettling the furnace after tapping a heat is different from the European practice. In the United States the furnace operators try to remove slag or steel left on the bottom and close the tap hole when the bottom is relatively dry and clean. During fettling the fuel is cut down and it is shut down completely for closing the tap hole. This makes the work much easier for the furnace crew and because they can see better, not being bothered by an excessive heat, they can do a very good fettling job. For the closing of the tap hole the temperature of the furnace is usually so low that the last treackles of steel or slag freeze, sometimes without "drying out" with dolomite. The first plug in the tap hole is made by ramming dead burned grain refractory material against a rabble placed in front of the tap hole through the door opening. This very human approach to a difficult and hard job helps to maintain the bottom and the banks in a good condition at a certain cost.

In addition to the time lost on repairs and fettling when the furnace is empty after tapping a heat, the time of the next heat is also greatly affected owing to the lowering of the temperature of the furnace. Also sudden and frequent temperature jumps may cause serious spalling of basic bricks and shorten the life of those expensive refractories.

With the advent of the all-basic furnace, it might be desirable to consider some features of the usual European practice. In Europe very thorough bottom, bank and tap hole repairs are often made once a week, usually on Sunday, and it takes approximately from six to sixteen hours to wash out and make up the bottom and the banks. During the week after each heat, if there are no holes in the bottom and banks, the fettling is limited to a minimum and is usually done without any cutting down of the fuel input. After tapping a heat, high temperature is maintained to facilitate quick drainage and if there are no dangerous holes spotted in the bottom or banks, charging starts immediately with the first box of light scrap dumped right in front of the tap hole. This scrap freezes slag or steel and gives the men working at the tap hole a chance to clean quickly the tap hole and ram in the first refractory plug. Meanwhile the furnace is charged and the banks are fettled simultaneously. This practice where the furnace is seldom cooled off is one of many factors contributing to the excellent performance of the European all-basic open hearth furnaces. The life of a European basic roof can easily reach 2000 heats and there are even reports of 3000-heat campaigns.

The European all-basic furnaces have a much longer life than so far any of the all-basic furnaces built in the United States. This can be explained by much smaller size, gaseous fuels and different design of the European furnaces.

Any slag or steel left in the holes in the banks or in the bottom contains iron oxide as a potential nucleus of serious troubles. Therefore, steel or slag must be removed completely from the holes and replaced by a good refractory material.

The removal of steel from holes in the bottom or banks of a tilting furnace is usually limited to the cutting of the ridges by mechanical or chemical means. When the furnace is tilted, steel flows out of the hole leaving it dry. After filling the hole with refractory material, the furnace is returned to its normal horizontal position.

Shops with stationary furnaces use various methods of steel and slag removal from the holes in the bottom or in the banks. The most popular way seems to be by blowing with air, but sometimes hard work with steel or wooden rabbles cannot be avoided. Cutting ridges with fluorspar facilitates removal of steel or slag from the holes. Ferro-silicon and aluminum are undesirable for this purpose, because they may penetrate rapidly too deeply into the bottom. For removal of steel from easily accessible holes, some shops use paddles which can be picked up by the charging machine, like charging boxes, and maneuvered by the charging machine operator as directed by the first helper or by the melter. These paddles can break thick ridges or dikes or they can splash out steel from the holes. Sometimes a hole can be scraped out clean by means of a paddle if steel or slag is "thickened up" by dumping some dolomite into the pool.

Blowing with air should not be abused as it might sometimes do more damage than good. Especially susceptible to damage by blowing with high pressure air are new rammed bottoms and cold rammed tap holes. During violent blowing with high pressure air, particles of rammed material may be blown away.

Various devices have been tried to facilitate quick drying out of holes in the bottom. For example, in England a machine has been designed as an accessory for the charging machine, which employs a vacuum to lift liquid steel or slag from the hole to a refractory lined container.

The choice of material used for patching of holes is usually dictated by the shape, depth and location of the hole. Shallow holes in the bottom may be repaired with fast sintering double burned dolomite without any slag

addition. For the same kind of holes in the banks, some clean ground open hearth slag should be mixed with dolomite. A little better job can be done by using magnesite materials, such as basifrit which should be mixed with about 6 per cent of slag for repairing the holes located in the banks. It takes longer time to burn this than burned dolomite but it is a much faster process than sintering of grain magnesite with high magnesia content.

During the last few years special quick setting magnesia mixes have been very successfully used. Very deep holes that required many hours for repairing with magnesite can now be fixed in a matter of minutes by dumping hot patching material. In most cases, as soon as the hole is filled up and the furnace is otherwise ready, charging can begin immediately. It is well worthwhile to remember that it is better to overestimate the amount of material required to fill up the hole with a solid monolithic mass and have some material left, than underestimate the necessary amount and find that some more has to be prepared while the hole is half filled with quick setting mix. For best results, water should be added much in excess of the amount normally required for the same material as if used for cold ramming. In order to prevent sticking of the mixture to the shovels, a certain area of the floor can be covered with a thin layer of double burned dolomite and the ready-to-use-mixture placed on top of it.

Quite recently a new material for hot repairs appeared on the market that requires no water addition. It sinters rapidly and has a very good stability.

Crushed raw dolomite is the quantitatively predominant fettling material in the U. S. It is the least expensive expendible material which serves its purpose very well in spite of slow bonding rate and endothermic reactions of calcination in the open hearth furnace. The iron oxide for the sintering of the raw dolomite is supplied by the furnace atmosphere and this accounts for the darkening and sintering of the raw dolomite when it is placed on the banks before the slag forms.

The amount of raw dolomite used in the American practice varies between 5 and 110 lb per ton of produced ingots depending on the local practice and on the size of the furnace. In Europe, due to a different fettling practice, materials with a slow bonding rate like raw dolomite are very rarely used.

Dead burned dolomite is usually produced in rotary kilns at a temperature of about 3000 F. Iron oxide is added to increase the stability of the product and to speed up the sintering process. This means that a portion of the lime in the dead burned dolomite is already combined as calcium ferrite before the product is delivered to the plant.

Very often some oil is added to the dead burned dolomite to increase the angle of respose and facilitate the fettling of the banks. For good results the SiO_2 content of the double burned dolomite should be as low as possible, preferably below 1.5 per cent.

In Europe, in addition to the single and double burned dolomite, the before mentioned dolomite-tar mixture is very successfully used for fettling of the banks. Tarred dolomite will even stick to the rough surfaces of the furnace brickwork. While the tar burns out, the dolomite gets sintered in place, creating good, if temporary protection. Probably equal results could be obtained with a similar material in this country.

The American practice seems to favor finely ground chrome ore for fettling of the upper portion of the banks including sometimes exposed back, front and wing-walls. Less expensive materials, like finely ground dead burned dolomite mixed with tar, would probably do a better job.

If it was not for the precious time factor involved, the best material for all furnace repairs would still be the grain magnesite.

To obtain a much faster burning-in rate, certain magnesite materials are marketed with some MgO substituted by CaO which forms calcium silicates and calcium ferrite acting as coalescent agents. Consequently a much faster bonding rate is created at a cost lower MgO content and poorer stability.

The last operation before shutting down a furnace at the end of the campaign is usually a good washing out of the bottom and banks. The time required to wash out a bottom depends on the condition of the bottom and on the kind of resurfacing planned. Any materials that help to speed up the washing out of the bottom without doing any damage to the refractory materials may be used. The most common are fluorspar, sand and cast-iron borings.

Cold resurfacing of the bottom requires a very thorough wash out which should be followed by the removal by any slag or steel left in the bottom and banks. This is done when the furnace is cold, usually shortly before resurfacing of the bottom. Cold resurfacing of the bottom is almost identical to the ramming of a new bottom; the only difference is the quantity of ramming material used. Cold resurfacing of the bottom restores the original shape and usually saves valuable time compared to the hot resurfacing of the bottom.

Some plants do the whole job, i.e., washing out and hot resurfacing of the bottom and banks, before shutting down the furnace for rebuild. While doing it that way, very high temperatures are available for burning-in of the refractory materials, and if any damage is done to the furnace brickwork it is practically meaningless. Whether such prepared bottom and banks will show any disintegration will depend upon the humidity of the air and upon the time necessary for the rebuilding of the furnace. The generally accepted practice is rather to make up the bottom and the banks during heating up of a rebuilt furnace. The choice of refractory materials for hot resurfacing depends on the time available and on the desired stability of the bottom and banks.

For fast hot resurfacing, double burned dolomite can be used, but the best material for this purpose is always high quality grain magnesite.

Remarkable progress has been made during the last decade in the construction and maintenance of the open hearth furnace bottoms. However there is still room for improvement along the following lines:

1. Fast installation of relatively inexpensive bottom with the highest packing density and good resistance to the soaking action of low carbon heats.
2. Improved drainage of the hearth by the continuous maintenance of the proper contour of the bottom.
3. Better, specially graded fettling materials with steeper angle of repose and higher packing density.
4. Adoption of some features of European practice.

Billet Heating— New Johnstown Rod Mill

By F. R. PULLEN

Fuel Engineer, Johnstown Plant, Bethlehem Steel Co., Johnstown, Pa.

. . . . furnace for new rod mill at Johnstown plant was put into service with a minimum of interference to operations . . . . performance of furnace has been excellent, hourly tonnage rates of over 60 tons have been attained and monthly average fuel consumption has been as low as 1,190,000 Btu per ton . . . .

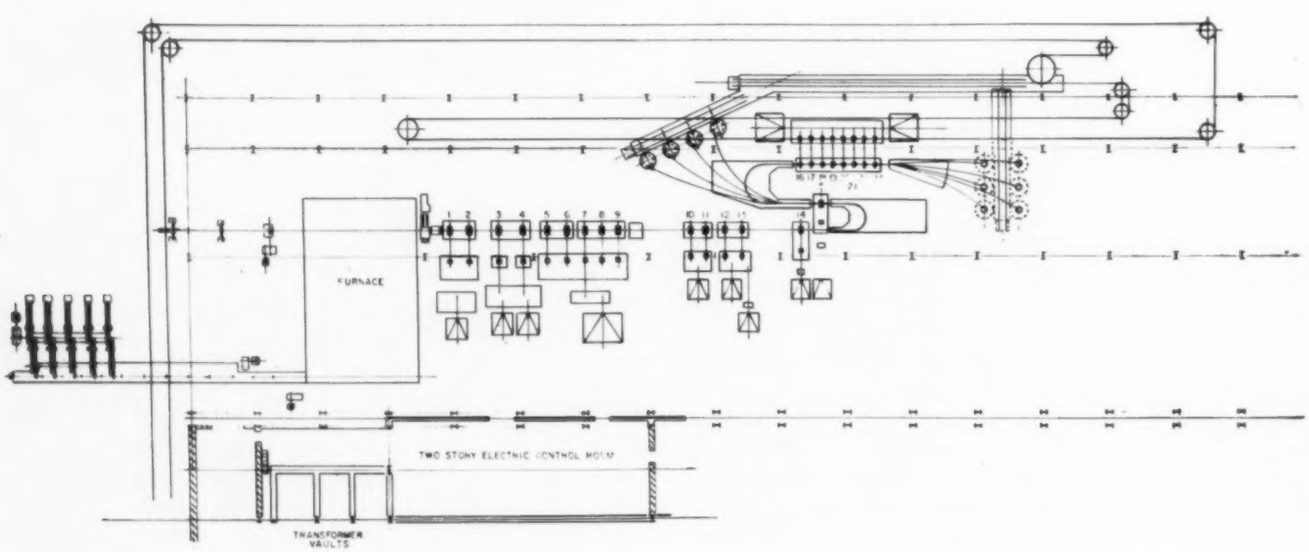
▲ THE new rod mill installed at the Johnstown plant of Bethlehem Steel Co. is a completely modern, high-speed rod mill. The construction and installation of this mill presented many problems since space limitations dictated that the new mill must occupy the site and buildings and utilize the same billet yard as the old 16-stand mill.

Figure 1 shows the general arrangement of the new rod mill. Since the mill was the only source of rods for the wire mill, it was mandatory to keep the old mill operating as long as possible during construction of the new mill. This situation posed some special planning problems and called for air-tight scheduling to maintain simultaneous excavation and construction operations. While the actual construction period extended over nine months, only the final twenty-seven days required a complete shut down of the mill.

The rods rolled at Johnstown represent a wide variety of grades and end uses. The preponderant tonnage is in wire commodities such as cold-heading, electro-plating, flat rolling, rope, spring wire, and fine wire. These and other end uses call for the closest possible control of rod section, surface, and other quality conditions affected by mill design and rolling practice.

The original heating furnace has been built approximately fifty years ago. It was a conventional side-charged, side-discharged furnace with an effective

Figure 1 — General plan of new rod mill at Bethlehem Steel Co.'s Johnstown plant.



hearth length of 25 ft and a width of 32 ft. Its capacity had been increased to the limit when the mill was converted to three-strand operation in 1948.

The rolling rate of the new mill was expected to be above 40 tons per hour on the average, with peak rates as high as 70 tons. Since the existing furnace was already operating at maximum rate in order to maintain the 30-ton per hour average on the old mill, it was obvious that a new furnace must be included with the new mill. Here again, space was at a premium. The problem was further complicated by the fact that the old furnace had to operate until the mill was shut down and the new furnace would have to be ready to operate before the installation of the mill was completed to allow for drying out and heating-up prior to operation.

Whereas the old mill utilized 1¾ in. square billets, 30 ft long, the new mill would utilize 2½-in. square by 30 ft length billets. Provision was also to be made for heating 3 x 3-in. square billets, 30 ft long in the future.

Engineering studies of the mill and the mill building indicated that the maximum distance between the center line of the mill and the center line of the new billet charger was about 42 ft. This length was limited by the electrical control room which was located, in part, behind the furnace. Actually, in order to allow sufficient clearance around the rear of the billet pusher for proper maintenance, it was necessary to reduce the hearth length to 41 ft. It was originally planned to utilize the stack and at least a portion of the old flue to the stack that served the original furnace. As engineering progressed, these plans were changed when it became necessary to remove the old furnace stack to provide space for the hot-coil conveyor.

Plant fuel balances indicated that a recuperator was to be included with the furnace; the installation of this recuperator and new stack in an already crowded area presented quite a problem. Taking a cue from some of the strip-mill furnaces, it was decided to install the recuperator above the furnace. The furnace proper was designed using the existing buckstays on the front of the furnace, since there was only a slight difference in the location of the center line of the new and the old mill. Supporting structural work for the recuperator

Figure 2 — Excavation has been made for billet pusher.

Figure 3 — Foundation for billet pusher.

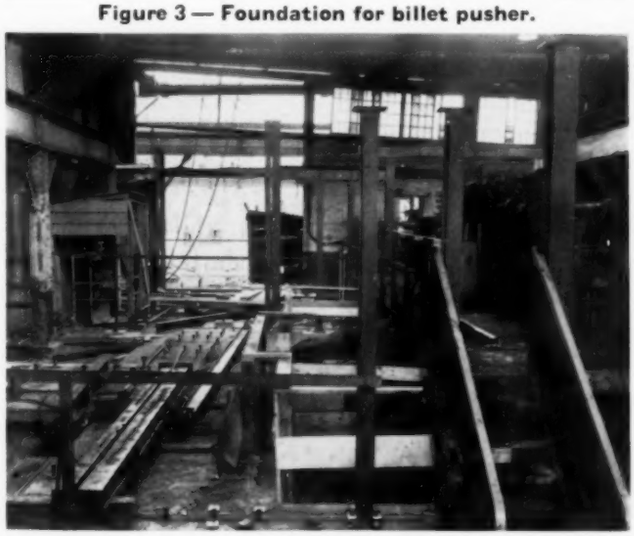


Figure 4 — Steel is being erected for recuperator and stack.

Figure 5 — Construction for rear buckstays, recuperator and stack.

Figure 6 — Brick and steelwork of old furnace were torn out as shown. New steelwork in front is for front burner wall.

Figure 7 — Excavation was well along at the end of 60 hr. Bulldozer is excavating below location where new hearth will be.

which was to be located above the furnace was designed to be incorporated into the sidewall buckstays of the furnace and the cross members were designed into the roof-supporting steel. With the recuperator above the furnace, it was desirable to erect the stack in the same general location. Supporting steel had to be provided to carry the weight of the stack and the stack lining. The waste gas exit from the furnace is a vertical flue with gases traveling upward into the recuperator inlet chamber and then horizontally back toward the front of the furnace. They are then led into the base of the stack where they rise and are discharged into the atmosphere. It was felt that with such an arrangement, the draft losses could be kept to a minimum and that a natural draft stack could be used.

Since it would be necessary to be completely out of production during the time the new furnace and the roughing train of the mill were installed, it was necessary to keep continuously in mind during all engineering work, that as much work as possible must be completed prior to the shutdown date. If this required additional structures, supporting members, or some temporary work, this must be done. It was imperative that the engineers continually check and recheck conditions in the field as the design progressed. Finally, the designs were completed and the work proceeded into fabrication and erection.

Figures 2, 3, 4 and 5 were taken at least one month before the mill shutdown date. Prior to the shutdown, the rear buckstays, supporting steel for the recuperator and stack, the furnace uptake, recuperator, and the stack were installed and all lining was completed. During the same time, construction of the finishing train was proceeding in an area not presently occupied.

With all material on hand and all preliminary construction finished, a complete construction schedule for the remaining portion of the program was drawn up. On November 14, 1955, the old furnace and mill were shut down. Water sprays and air blowers were used to cool the furnace refractories to permit dismantling of all brick and steel work down to the concrete pad, with the exception of the front buckstays. This work was completed in approximately 60 hr. Figures 6 and 7 show the extent of the tear-out.

At this time, reconstruction began with the forming and pouring of the extended furnace foundation mat and the setting of the new furnace buckstays. Figures 8 and 9, taken four days after shutdown, show this phase of the construction. The foundation for the billet pusher was completed and the pusher installed. As the furnace buckstays were installed, the hearth supporting steel and the roof steel were installed, as seen in Figure 10. This photograph was taken nine days after shutdown. Following the erection of the furnace steel work, bricklayers moved in to install the hearth, sidewalls, burner walls, and the suspended roof. Simultaneously, the furnace combustion-air fan, cold-air piping to the recuperator, and the hot-air piping from the recuperator to the furnace proper, along with the gas-supply line to the burners were installed. Following completion of this phase of the work, the furnace control equipment—consisting of roof temperature controls, fuel-air ratio control, furnace-pressure control, gas-pressure regulator, and other recording instruments connected with the furnace—was installed, wired and piped, ready for operation.

Figure 8 — This progress photograph was taken four days after shutdown. Foundations were installed by plant personnel.

Figure 9 — Forms were well along at the end of four days, and these here are for hearth supports.

Figure 10 — Steel for supporting hearth and roof are here being installed.

On December 6, 1955, 21 days after mill shutdown date, the furnace was sufficiently advanced for drying-out fires to be lighted. As the completion of the mill installation was not scheduled for several days, the furnace was dried out and brought up to temperature slowly. During this time, the installation of the billet-charging and billet-pushing equipment, along with minor parts of the furnace-control equipment, was completed, and on December 11, 1955, steel was charged into the furnace preparatory to rolling the following day. Figures 11 and 12 show the furnace in final stages of construction.

The furnace hearth is supported on H-beams resting on reinforced concrete piers, as was seen in Figure 10. A layer of insulating concrete was placed on the steel plate to establish the final hearth contour. On top of the concrete, a 13-in. course of second-quality fire brick forms the sub-hearth. The main hearth is constructed of alternate rows of magnesite and chrome brick, each row three courses wide. At the rear of the furnace and extending for about 18 ft down the hearth, dry steel skids are imbedded in the hearth. Dry alloy skid ears in the charging area take the wear of the billets as they are pushed across the furnace. Figure 13 is a view from the hearth to the rear of the furnace. The dry skids can be seen projecting above the hearth.

The side walls of the furnace were constructed of first and second-quality fire brick in the charging end of the furnace. The side walls in the hot zone were constructed of a rammed plastic refractory.

The suspended roof has a clearance of 5 ft-1½ in. above the hearth at the push-out doors and is constructed of super-duty fire brick. Toward the rear of the furnace, the hearth and roof converge gradually. In this area, the roof is constructed of first-quality fire brick.

The burner wall contains the cast burner ports for the 26 burners. Air is supplied to the burners from the air chamber located directly behind the burner wall. Gas burners are silicon-carbide tubes and are located near the bottom of the air port. By introducing the gas below the air stream, a blanket of rich gas protects the hot steel lying on the hearth. The relatively slow mixing of gas and air also produces a slower burning, more luminous flame. Due to the large number of burners, the flame covers practically the entire hearth area, Figure 14 shows the front of the furnace as construction of the air chamber and burner walls is

Figure 11 — Furnace here is in final stage of construction. In foreground is seen the new mill.

Figure 12 — This view of furnace was taken from other end to that shown in Figure 11.

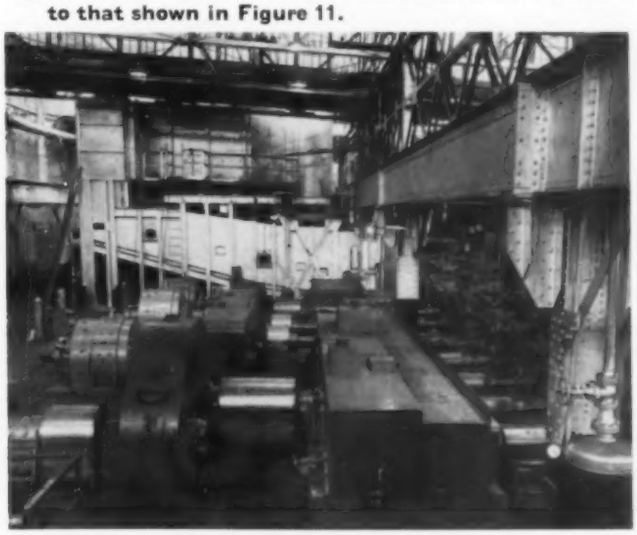


Figure 13 — Dry skids are shown projecting above hearth in this view looking to the rear of the furnace.

Figure 14 — Construction of the air chamber and burner walls is starting as shown at the front of the furnace.

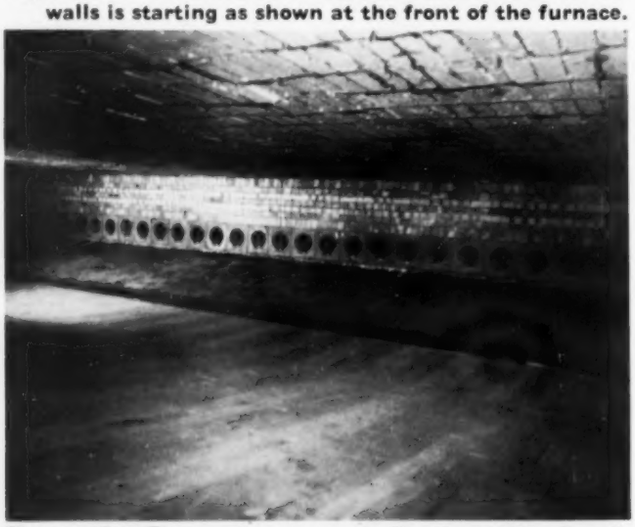


Figure 15 — Flame covers practically the entire hearth area.

starting. The ducts overhead are the air connections between the air chamber and the hot-air pipe above the furnace roof. Figure 15 is a view of the completed burner wall with the gas burner installed. Figure 16 is a view of the discharge door showing the rammed side wall, the sloping wall below the burners, and the end of the burner wall.

Figure 16 — Side wall above discharge door is of rammed type construction.

Figure 17 — Flue gas travels up uptake and then in horizontal direction to the front of the furnace.

Figure 17 is a view at the rear of the furnace showing the uptake from the furnace to the recuperator inlet. The flue gas travels up this uptake and then in a horizontal direction toward the front of the furnace in passing through the recuperator. The recuperator discharges directly into the base of the stack.

Figure 18 is a view of the side of the furnace taken from charging pulpit. Figure 19 is a front view of the furnace.

The metallic recuperator consists of 12 rows of tubes with 11 tubes in each row. The tubes are suspended in the gas stream and consist of an inner and an outer tube. Air from the fan is introduced through a cold air manifold to the inner tube. It passes downward to the bottom where it is exhausted into the annular ring between the inner and outer tube. The velocity in this

Figure 18 — Completed furnace is shown from the charging pulpit.

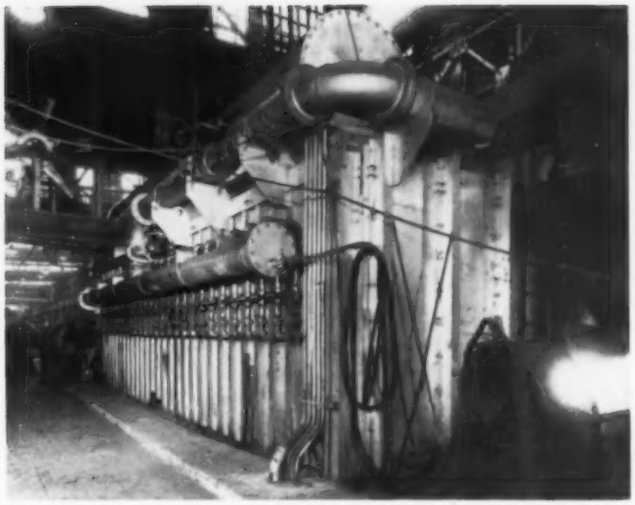


Figure 19 — Furnace has given excellent operating results.

passage is relatively high to insure good heat transfer. Hot air is collected in a hot manifold and piped to the front of the furnace. Air preheat averages 650 F with inlet flue gas temperature of 1450 F. In order to keep the weight of the recuperator and stack to a minimum, insulating fire brick and light-weight insulating concrete were used throughout this area.

Figure 20 shows the furnace control panel.

Furnace temperature is automatically controlled from a thermocouple located in the roof of the furnace adjacent to the push-out door. The temperature impulse establishes a demand for fuel-gas flow. The fuel-air ratio controller in turn supplies the proper amount of air for the fuel input. The furnace-pressure impulse is taken from the roof of the furnace near the point of temperature measurement to record and control the furnace pressure. A butterfly-type alloy damper in the stack is operated by the furnace-pressure controller and maintains a positive pressure within the furnace at all times.

In almost 18 months of operation, the furnace has required practically no maintenance other than some small patches in the flat section of the hearth. After about one year of operation and following a successful application in the ten-inch bar-mill furnace, silicon-carbide brick skids were installed from the end of the dry steel skids down to the flat section of the hearth. The silicon-carbide skids have been in operation in the bar-mill furnace for approximately one year with every indication that they will last much longer.

During breaking in the new mill and the mill crews, no accurate evaluation of the furnace operation could be made. Only in recent months has it been possible to get some true measure of the furnace's performance. The maximum tonnage rates have probably not yet been reached. However, an hourly tonnage rate of over 60 tons has been attained. Maximum turn tonnage rolled to date is 461 tons, an average of 57.6 tons per hour, and the record tonnage to date is 1105.3 tons, or 46 tons per hour. Fuel consumption on a daily basis has been as low as 1,080,000 Btu per net ton heated per day, with a monthly average of 1,190,000 Btu's per ton. From these data, it would appear that the furnace has met the conditions imposed upon it by the mill and has done so with a minimum of maintenance cost.

A project of this nature and magnitude presents many unusual problems. The fact that it was brought to a successful conclusion within the time limit and with a minimum of interference with the operations is a credit to all connected with the job. It could not have been accomplished without the utmost cooperation between the operating department and the engineering and construction divisions.

DISCUSSION

PRESENTED BY

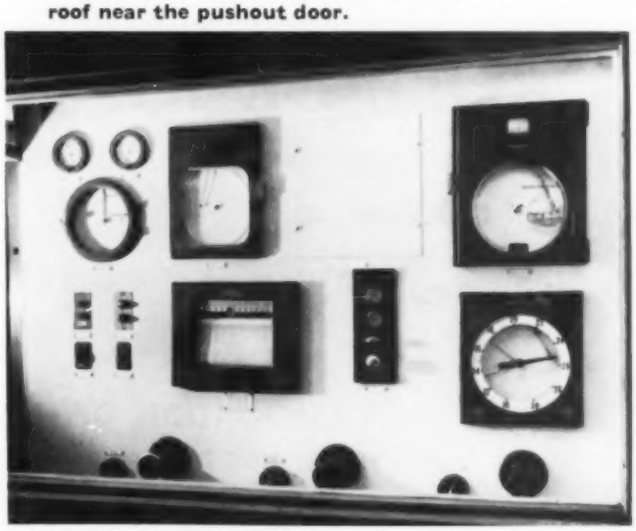
F. R. PULLEN, Fuel Engineer, Johnstown Plant, Bethlehem Steel Co., Johnstown, Pa.

B. M. PUTICH, Sales Engineer, Bloom Engineering Co., Pittsburgh, Pa.

JAMES E. HOVIS, Manager Industrial Furnace Div., The Gas Machinery Co., Cleveland, Ohio

Member: What are the hearth dimensions? Have you heated any steel in this furnace subject to decarbonization, and if so, what do you do?

Figure 20 — Furnace temperature is automatically controlled from a thermocouple located in the furnace roof near the pushout door.



F. R. Pullen: The hearth dimensions were forty-one feet and that is an effective length, in other words, from the center line of the mill to the center line of the billet pusher, by thirty-two feet in width.

Now with regard to decarbonization, we roll a lot of material on that mill that is subject to decarbonization. High carbon steels and some alloys for cold heading, spring wire, rope wire, and that sort of thing. Decarbon results to date runs about 0.003 in. total affected depth as a maximum. In talking with the rod mill superintendent the other day he indicated that it was running from 0.001 to 0.003 in. in depth.

As to what we do in the case of a mill shutdown, we just shut the furnace down, drop the temperatures down as quickly as possible, and maintain pressure within the furnace and hope that the delay is not too long.

B. M. Putich: I would like to ask Mr. Pullen how high the burners are off the hearth. It seems to me with the burner arrangement he shows that the hot spot may be several feet back of the discharge point, which may, when he is pushing the furnace, give some sticker trouble.

F. R. Pullen: The burners are located 25½ in. above the hearth.

Our experience to date indicates that the hot spot appears to be just about at the bottom of the slope. In other words, where the sloping hearth comes into the flat portion of the hearth. We had trouble with stickers when starting up the mill. However, this problem disappeared as soon as a normal operation was approached.

James E. Hovis: What air pre-heats are you getting; possibly you have a figure tied in with your higher tonnage production rates?

Another question, in the illustrations, it appeared that you had a radius on your hearth (both the steel work pictures and the brick work pictures gave the appearance) and I think probably you are trying to avoid pile-ups. It would be interesting for us to get a report on what the results are.

Finally, have you had the occasion to have a tight, restricted knuckle on a similar mill operation in the furnace roof, and if so, I think it would be interesting to get your reaction as to the temperature curve on the steel as it is heated. In other words, the problem of decarb was mentioned. With the tight knuckle you can put a break in your furnace temperature curve, namely, running a colder back end and a hotter discharge zone, thereby holding the steel back fairly late in the heating cycle, and then bringing it up the temperature rapidly. What would be your comment as to this type of design versus the roof design you discussed?

F. R. Pullen: Our average preheat temperature is about 650 F. We designed the furnace on a basis of 800 F air pre-heat, and we may possibly get to that temperature as we increase production because at the present time our flue gases leaving the furnace are about 1450 F, where as we estimated that they would be probably in the neighborhood of 1800 F. So we are just not getting the high temperature gases back into the recuperator to get the air preheat we expect, which after all, is good.

As to the radius on the hearth, there was nothing wrong with the illustrations. The sloping section of the hearth is built on a radius of 380 feet. This reduces to a minimum the possibility of billet pile-ups. It will not eliminate billet pile ups caused by poor sections on the billet mill.

With respect to the type knuckle on the furnace, we have no such knuckle on this furnace, and I do not know whether it would be desirable or advantageous, particularly, on this particular furnace. We have a similar furnace to this on the 10-in. bar mill that I mentioned previously, and it was subject to much wider rolling rate variations than we are on the rod mill. After all, once you get a rod mill going, you go along at a relatively uniform rate, whereas in a bar mill that thing is all up and down.

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D-C MILL MOTOR STANDARDS

AISE STANDARD NO. 1

Revised, September, 1957

Published by

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1. General

a. The development of the AISE mill motor standards is outlined in the 1926, 1928–29, 1940, 1947, and 1956 Proceedings of the Association of Iron and Steel Engineers.

b. The standard d-c mill motor is detailed on the accompanying Table I and Figures 1 and 2.

c. Frame No. 2 is a carry-over from the 1940 mill motor standard. Frames 602 through 618 are unchanged from AISE Standard No. 1 (September, 1947).

d. This present revision was made in order to add three new larger frame sizes, with ratings of 275, 375, and 500 horsepower. Some items have been standardized in these new frames which are not included in the smaller sizes as a standard. Thus, blank spaces in the table are for these dimensions which are not standardized for all frames. Because of the applications of the three new large sizes, some items standardized in the smaller frames are not standardized in the newer frames and these are also indicated by blank spaces in the table. Some of the other differences in the three large frame sizes are that these:

1. Standardized motor frames are split but not hinged.
2. Standardized motor frames are applicable for coupled service only.
3. Standardized motors are not available with back axles. Therefore, Figure 2 is not applicable to the three larger frames.
4. Standardized motors are not furnished at 550 volts. However, they are equivalent in insulation level to the smaller frame sizes and can be used on variable voltage applications.

2. Ratings:

a. The basic 1-hr, 75 C totally enclosed ratings of the standard line will be as follows: 5 hp, 7½ hp, 10 hp, 15 hp, 25 hp, 35 hp, 50 hp, 75 hp, 100 hp, 150 hp, 200 hp, 275 hp, 375 hp, and 500 hp. Other ratings and data will be as given in Table I.

3. Dimensions:

The outline dimensions of the standard line of motors will be as shown in Figure 1.

4. Back axle details:

Details of the back axle bearing construction are shown in Figure 2 for frames No. 2 through No. 618.

5. Tolerances:

a. The sides of the motor feet, parallel to the shaft, are machined to the tolerances shown in Figure 1. A standard tolerance is also shown for the height from the bottom of the motor feet to the centerline of the armature shaft.

Table 1 — AISE Standardized D-C Mill Motor Ratings.

AISE MOTOR FRAME	TOTALLY ENCLOSED 1 HOUR, 75 DEG. C. RISE HP	TOTALLY ENCLOSED 1 HOUR, 75 DEG. C. RISE RPM SERIES	RPM COMPOUND	RPM SHUNT	TOTALLY ENCLOSED 5 HOURS, 75 DEG. C. RISE HP	RPM SERIES	RPM COMPOUND	RPM SHUNT	PROTECTED SELF-VENTILATED CONTINUOUS, 75 DEG. C. RISE HP	RPM SERIES	RPM COMPOUND	RPM SHUNT	PROTECTED SELF-VENTILATED 1 HOUR, 75 DEG. C. RISE HP	RPM SERIES	RPM COMPOUND	RPM SHUNT	TOTALLY ENCLOSED 60°75°C. RISE & PROTECTED SELF-VENTILATED CONT. 75°C. RISE TORQUE IN POUND FEET RATED 75°C. RISE SERIES	COMPOUND	SHUNT	MAX. STARTING* SERIES	COMPOUND	SHUNT	MAX. RUNNING** SERIES	COMPOUND	SHUNT
230 VOLTS																									
2	5	900	1025	1025	3 1/2	1080	1200	1100									29	25.5	25.5	145	115	92	116	90	75
602	7 1/2	800	900	900	4 1/2	1085	1050	965	7 1/2	800	900	900	9 1/4	700	800	885	49	44	44	245	198	158	196	154	130
603	10	725	800	800	6	950	925	840	10	725	800	800	12 1/2	645	725	785	72	65.5	65.5	360	295	235	288	230	190
604	15	650	725	725	7 1/2	1025	885	770	15	650	725	725	19	560	650	710	121	109	109	805	490	390	484	382	325
606	25	575	650	650	13	800	785	685	25	575	650	650	31 1/2	525	635	650	228	202	202	1140	910	730	912	710	600
608	35	525	575	575	18	740	675	600	35	525	575	575	44	475	540	575	350	320	320	1750	1440	1150	1400	1120	960
610	50	500	550	550	22 1/2	720	640	565	50	500	550	550	62 1/2	460	510	550	525	477	477	2625	2150	1720	2100	1670	1430
612	75	475	515	515	37	700	600	525	75	475	515	515	94	435	485	515	830	765	765	4150	3440	2750	3320	2700	2290
614	100	460	485	485	46	685	550	505	100	460	485	485	125	425	450	485	1140	1080	1080	5700	4860	3890	4560	3780	3240
616	150	450	460	460	66	675	520	480	150	450	460	460	187 1/2	410	440	460	1750	1710	1710	8750	7700	6150	7000	6000	5130
618	200	410	420	420	85	650	500	430	200	410	420	420	250	380	400	420	2560	2500	2500	12800	11250	8500	10000	9000	7000
620	275	370	390	390					275	370	390	390	350	350	370	390	3900	3700	3700	19500	16650	13320	15600	12950	11100
622	375	340	360	360					375	340	360	360	475	320	340	360	5790	5460	5460	29000	24600	19660	23200	19110	16380
624	500	320	340	340					500	320	340	340	625	300	320	340	8210	7720	7720	41100	34740	27790	32800	27020	23160
550 VOLTS																									
2	5	1015	1150	1150	3 1/2	1270	1300	1200									26	23	23	105	85	70	90	65	60
602	7 1/2	935	1035	1025	4 1/2	1210	1185	1050	7 1/2	935	1025	1025	9 1/4	825	925	1015	42	38	38	170	135	115	145	105	95
603	10	810	885	885	6	1115	1025	920	10	810	885	885	12 1/2	725	800	875	65	59	59	260	210	175	230	165	150
604	15	725	800	800	7 1/2	1060	1000	850	15	725	800	800	19	635	750	785	109	98	98	435	350	295	380	275	245
606	25	635	700	700	13	925	850	725	25	635	700	700	31 1/2	575	675	685	207	188	188	830	675	565	725	525	470
608	35	585	625	625	18	850	725	650	35	585	625	625	44	525	585	610	314	294	294	1255	1060	880	1100	825	735
610	50	530	585	585	22 1/2	750	700	600	50	530	585	585	62 1/2	475	560	575	435	449	449	1980	1615	1345	1735	1255	1125
612	75	510	550	550	37	740	635	570	75	510	550	550	94	445	515	540	772	716	716	3090	2580	2150	2700	2000	1790
614	100	475	500	500	46	710	575	525	100	475	500	500	125	440	475	490	1105	1050	1050	4420	3780	3150	3870	2940	2625
616	150	460	460	460	66	675	520	480	150	460	460	460	187 1/2	425	440	450	1710	1710	1710	6850	6170	5135	6000	4800	4280
618	200	415	415	415	85	650	500	430	200	415	415	415	250	380	400	415	2530	2530	2530	10100	9100	7600	8800	7000	6200

ADJUSTABLE SPEED DIRECT CURRENT MILL MOTORS SHUNT OR STABILIZED SHUNT WOUND		
AISE MOTOR FRAME	1 HOUR, 75 DEG. C., ENCLOSED CONT., 75°C., SELF-VENTILATED HP	RPM
230 VOLTS		
2	5	1025/2050
602	7 1/2	900/1800
603	10	800/2000
604	15	725/1800
606	25	650/1950
608	35	575/1725
610	50	550/1650
612	75	515/1300
614	100	485/1200
616	150	460/1150
618	200	420/1050
620	275	390/975
622	375	360/1080
624	500	340/1020

ENCLOSED FORCE-VENTILATED DIRECT CURRENT MILL MOTORS SERIES, COMPOUND, SHUNT AND STABILIZED SHUNT WOUND 230 & 550 VOLTS		
THE CONTINUOUS, 75 DEG. C. RISE RATINGS OF ENCLOSED FORCE-VENTILATED MOTORS ARE EQUAL TO THE 1 HOUR, 75 DEG. C. RISE TOTALLY ENCLOSED RATINGS WHEN THE REQUIRED VOLUME OF VENTILATING AIR FOR SUCH RATINGS IS SUPPLIED TO THE MOTORS.		
AISE MOTOR FRAME	REQUIRED CFM AIR	STATIC PRESSURE INCHES OF WATER AT MOTOR INLET
2	110	1
602	180	1/2
603	200	1/2
604	250	1/2
606	335	3/4
608	425	3/4
610	525	1
612	750	1 1/2
614	900	1
616	1200	1 1/4
618	1600	1 1/2
620	2000	1 3/4
622	2700	1 3/4
624	3500	1 3/4

* THE VALUES FOR MAXIMUM STARTING TORQUE ARE BASED ON THE FOLLOWING APPROXIMATE RATIOS TO THE CORRESPONDING 1 HOUR TOTALLY ENCLOSED TORQUE RATINGS:

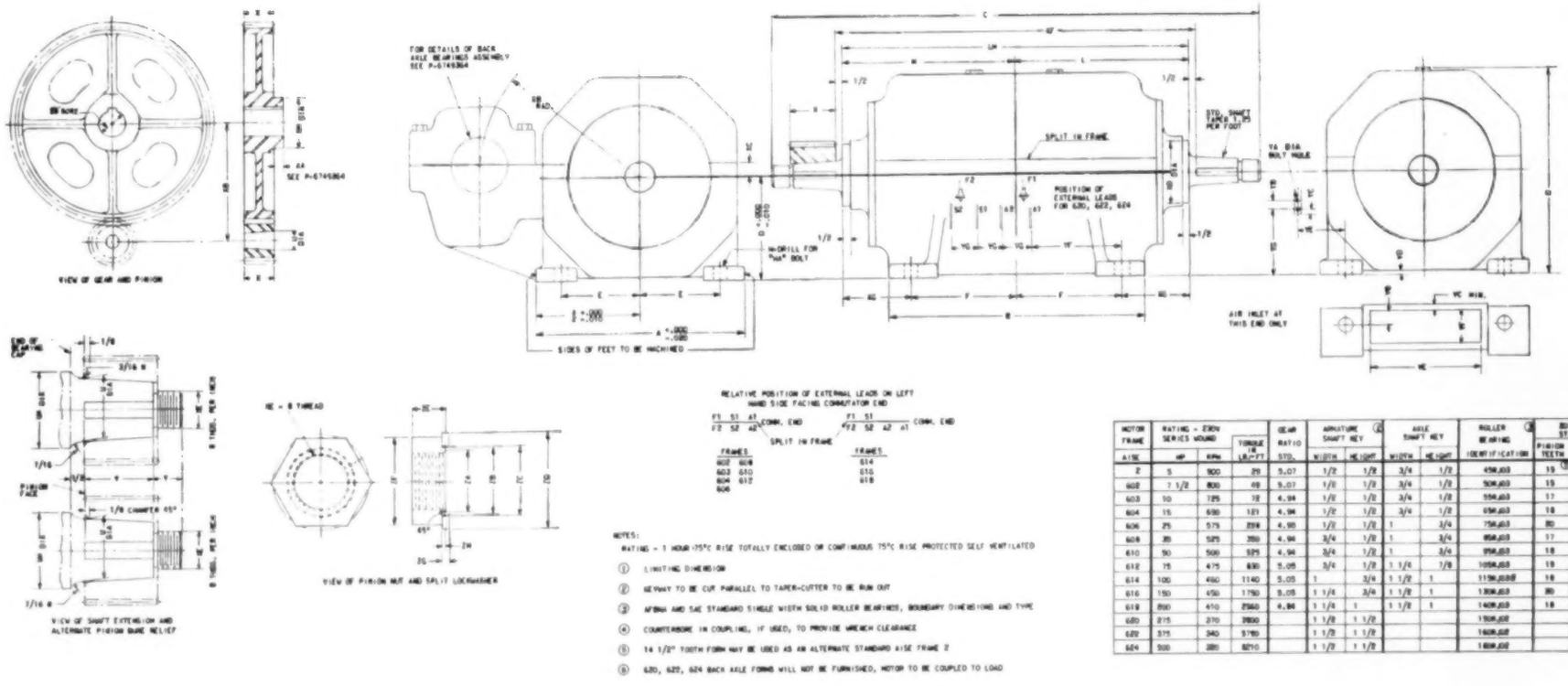
RATIOS

VOLTS	SERIES	COMPOUND	SHUNT
230	5	4.5	3.6
550	4	3.6	3

** THE VALUES FOR MAXIMUM RUNNING TORQUE ARE BASED ON THE FOLLOWING APPROXIMATE RATIOS TO THE CORRESPONDING 1 HOUR TOTALLY ENCLOSED TORQUE RATINGS:

RATIOS

VOLTS	SERIES	COMPOUND	SHUNT
230	4	3.5	3
550	3.5	2.8	2.5


VIEW OF GEAR AND PINION
SEE P-6749364
FOR DETAILS OF BACK AXLE BEARINGS ASSEMBLY SEE P-6749364
SPLIT IN FRAME
STD. SHAFT TAPER 1.75 PER FOOT
POSITION OF EXTERNAL LEADS FOR 620, 622, 624
DRILL FOR BOLT
SIDES OF FEET TO BE MACHINED
AIR INLET AT THIS END ONLY
VC MIN.
VIEW OF SHAFT EXTENSION AND ALTERNATE PINION BORE RELIEF
VIEW OF PINION NUT AND SPLIT LOCKWASHER
RELATIVE POSITION OF EXTERNAL LEAD ON LEFT HAND SIDE FACING COMMUTATOR END
COMM. END
SPLIT IN FRAME
FRAMES
602 608
603 610
604 612
606
FRAMES
614
616
618

NOTES:

RATING – 1 HOUR-75°C RISE TOTALLY ENCLOSED OR CONTINUOUS 75°C RISE PROTECTED SELF VENTILATED

① LIMITING DIMENSION

② KEYWAY TO BE CUT PARALLEL TO TAPER-CUTTER TO BE RUN OUT

③ AFBMA AND SAE STANDARD SINGLE WIDTH SOLID ROLLER BEARINGS, BOUNDARY DIMENSIONS AND TYPE

④ COUNTERBORE IN COUPLING, IF USED, TO PROVIDE WRENCH CLEARANCE

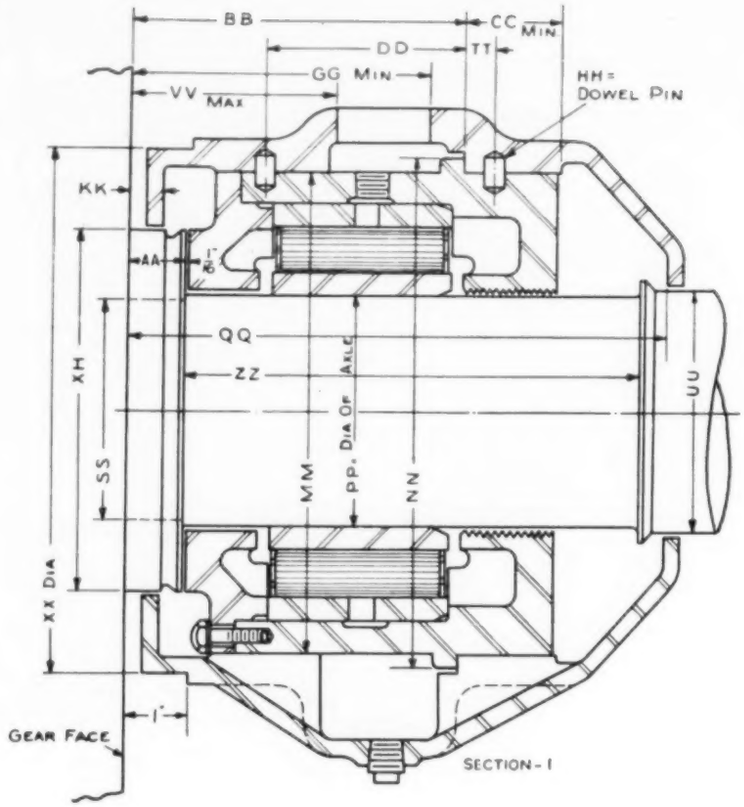
⑤ 14 1/2° TOOTH FORM MAY BE USED AS AN ALTERNATE STANDARD AISE FRAME 2

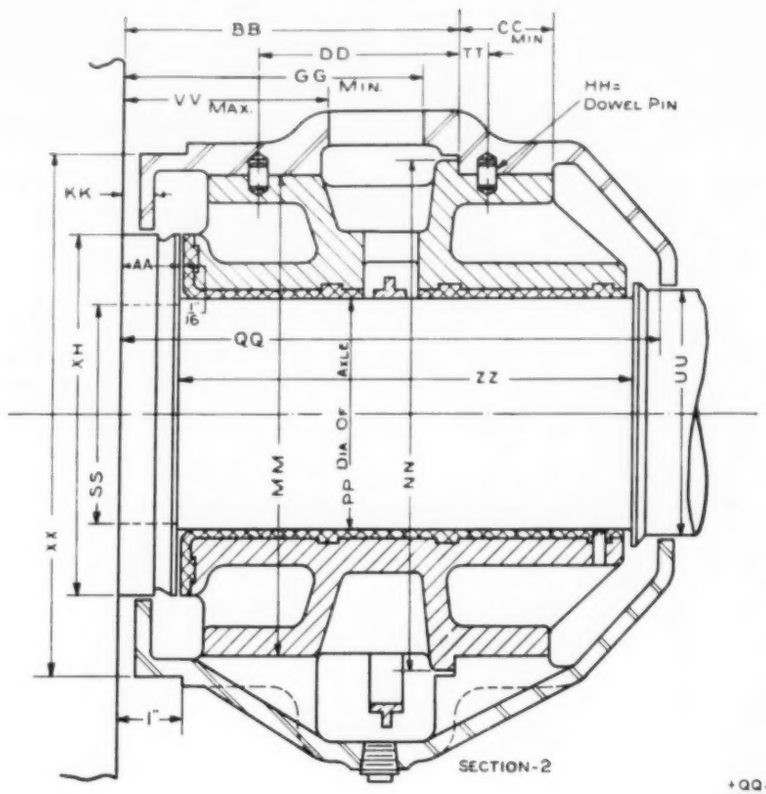
⑥ 620, 622, 624 BACK AXLE FRAMES WILL NOT BE FURNISHED, MOTOR TO BE COUPLED TO LOAD

MOTOR FRAME AISE	RATING – EXCH SERIES WOUND HP	RPM	TORQUE IN LB-FT	GEAR RATIO STD.	ARMATURE SHAFT KEY ② WIDTH	HEIGHT	AXLE SHAFT KEY WIDTH	HEIGHT	ROLLER BEARING ③ IDENTIFICATION	20° STUB TOOTH FORM STANDARD GEAR RATIO ⑤ PINION TEETH	GEAR TEETH	PITCH	FACE	GEAR CASE BELOW BASE
2	5	900	29	5.07	1/2	1/2	3/4	1/2	456,603	15	76	4	3	2 1/2
602	7 1/2	800	49	5.07	1/2	1/2	3/4	1/2	506,603	15	76	4	3	2 1/2
603	10	725	72	4.94	1/2	1/2	3/4	1/2	556,603	17	84	4	3 1/2	2 1/2
604	15	680	121	4.94	1/2	1/2	3/4	1/2	656,603	18	89	4	3 1/2	2 3/4
606	25	575	228	4.90	1/2	1/2	1	3/4	756,603	20	99	4	4	2 3/4
608	35	525	350	4.94	3/4	1/2	1	3/4	856,603	17	84	3	4 1/2	3 1/4
610	50	500	525	4.94	3/4	1/2	1	3/4	956,603	18	89	3	4 1/2	3
612	75	475	830	5.05	3/4	1/2	1 1/2	7/8	1056,603	19	96	3	5	3
614	100	460	1140	5.05	1	3/4	1 1/2	1	1156,603	18	91	2 1/2	5	4 1/4
616	150	450	1750	5.05	1 1/4	3/4	1 1/2	1	1306,603	20	101	2 1/2	5 1/2	4 1/2
618	200	410	2560	4.94	1 1/4	1	1 1/2	1	1406,603	18	89	2	6	5
620	275	370	3900		1 1/2	1 1/2			1506,603					
622	375	340	5780		1 1/2	1 1/2			1606,603					
624	500	285	8210		1 1/2	1 1/2			1806,603					

MOTOR FRAME AISE	A	B	C	D	E	F	H	HA	L	M	LH	O	SS BORE	U	UA	V	VB	VC	VD	VE	VF	⑥ WD	WB	XC	XD	XE	XF	XG	XH	Y	YA	YB	YC	YD	YE	YF	YL	ZD	ZA	ZB	ZC	ZE	ZF	ZG 81/16	ZM
2	15	19	32 7/8	7 5/8	6 1/4	8 1/4	25/32	3/4	12	12	24	15 3/4	2 5/8	1 3/4		2 3/4						2 3/4	11.375	7/8	4 1/2		25	3 3/4	4 1/2														2		
602	15	19	32 7/8	7 5/8	6 1/4	8 1/4	25/32	3/4	12	12	24	15 3/4	2 5/8	1 3/4	1.953	2 3/4						3 1/4	11.375	7/8	4 1/2	1	25	3 3/4	4 1/2	1 3/16														2 1/2		
603	17	21	37	8 1/2	7	9	29/32	7/8	13 1/2	13 1/2	27	17 3/8	3 1/8	2	2.130	3 1/4						3 1/2	12.625	1	5 1/2	1 1/4	26	4 1/2	5	1 1/4														2 1/2		
604	18	22	39	9	7 1/2	9 1/2	29/32	7/8	14 1/2	14 1/2	29	18 3/8	3 1/2	2	2.545	3 1/4						3 1/2	13.375	1	5 1/2	1 1/4	30	5	5 1/2	1 1/4														2 3/4		
606	20	24 1/2	42 1/4	10	8 1/4	10 1/2	1 1/32	1	15 1/2	15 1/2	31	20 3/8	3 7/8	2 1/2	2.838	3 3/4						4	14.875	1 1/8	6 1/4	1 1/2	32	5	6	1 3/8														3 1/2		
608	22 3/4	28 1/2	47 1/2	11 1/4	9 3/8	12 3/8	1 3/16	1 1/8	17 1/2	17 1/2	35	22 13/16	4 5/16	3	3.302	4 1/4						5	16.630	1 1/8	7 1/4	2	36	5 1/8	6 1/2	1 1/2														4		
610	24 1/2	30 1/2	50 1/4	12 1/8	10 1/4	13	1 3/16	1 1/8	18 3/4	18 3/4	37 1/2	24 7/8	4 11/16	3 1/4	3.725	4 1/4						5 1/4	17.833	1 1/8	8	2 1/4	38 1/2	5 3/8	7	1 3/8														4 1/2		
612	27	33	55	13 3/8	11 1/4	14 1/4	1 5/16	1 1/4	20 1/2	20 1/2	41	27 1/8	5 1/16	3 5/8	4.119	4 3/4						5 5/8	19.166	1 1/4	8 3/4	2 1/2	42	6 1/4	8	1 3/4														4 1/2		
614	30	37 1/2	60 3/4	14 3/4	12 1/2	16	1 9/16	1 1/2	23 1/4	23 1/4	46 1/2	29 3/8	5 7/8	4 1/4	4.514	4 3/4						6 1/4	21.860	1 1/4	10	3	47 1/2	7 1/4	9	1 7/8														5		
616	32 1/2	41	67 1/2	16	13 1/2	17 1/2	1 9/16	1 1/2	26	26	52	32 5/8	6 9/16	4 5/8	5.103	5 1/4						7	24.200	1 1/2	10	3 1/4	53	8 1/2	10	2														5 3/4		
618	36	45 1/2	70 5/8	17 3/4	15	19 1/2	1 13/16	1 3/4	27 1/2	27 1/2	55	36 1/16	7 3/8	5	5.500	5 3/4						7 1/2	26.750	1 1/2	10	3 1/2	56	8	11	1 9/16																
620	41 1/2	50	78	20 7/8	18	22	2 1/16	2	30	30	60	42		5 1/8	5.875	6 1/2	2 3/4	1	7/8	20	5 3/4	9 3/4			10	4	61	8		2	17/32	2	1	11 3/4	4 1/4	18 1/2	4 1/2	7 1/8	4 3/16	5	5 1/16	1 9/16	6 1/8	1/16	3/16
622	53 1/2	65	98 1/4	23	20	25 3/4	2 1/16	2	33	33	66	46 1/2		6 1/4	6.250	7	2 3/4	1	7/8	20 1/2	6	9 3/4			11	4	67	7 1/4		2 5/8	17/32	2	1	11 3/4	5 3/4	20	4 1/2	7 1/8	4 3/16	5	5 1/16	2 3/16	6 1/2	1/16	3/16
624	67 1/2	80	98 1/4	24	21	28	2 1/16	2	36	36	72	48 1/2		7	7.000	8	2 3/4	1	7/8	30	7 1/2	9 3/4			12	4	73	8		2 5/8	17/32	2	1	11 3/4	5 3/4	24	4 1/2	7 1/8	4 3/16	5	5 1/16	2 3/16	6 1/2	1/16	3/16

Figure 1 — AISE Standardized D-C Mill Motor Dimensions.





+QQ-MINIMUM DIMENSION (APPROX.)
*MM-FOR SLEEVE AND ROLLER BEARINGS
xKK-MAXIMUM DIMENSION (APPROX.)
#ZZ-IF OIL SLINGER IS USED
●OR EQUIVALENT

AISE MOTOR FRAME	SECT NO.	AA	BB	CC	DD	GG	HH	KK x	MM *	NN	+.0000 -.0005 PP	QQ +	SS	TT	MAXIMUM UU	VV	XH	XX	ZZ #	♦AFBMA BEARING IDENTIFICATION
2	1-2	7/8	4 5/8	1 1/8	2 1/2	4 3/8	3/8	1/2	5.937	6 7/16	2.7570	7 1/4	2 5/8	1/2	2 13/16	2 7/8	4 1/2	7 1/8	5 3/4	70 MWE 38126
602	1-2	7/8	4 5/8	1 1/8	2 1/2	4 3/8	3/8	1/2	5.937	6 7/16	2.7570	7 1/4	2 5/8	1/2	2 13/16	2 7/8	4 1/2	7 1/8	5 3/4	70 MWE 38125
603	1-2	7/8	5	1 3/8	2 7/8	4 1/2	3/8	1/2	6.500	7	3.1507	7 3/4	3 1/8	1/2	3 3/16	3	5	7 3/4	6 1/2	80 MWE 42140
604	1-2	1	5 3/8	1 1/2	3 1/8	4 7/8	3/8	1/2	7.312	7 3/4	3.5445	8 1/2	3 1/2	1/2	3 9/16	3 3/8	5 1/2	8 1/2	7 1/4	90 MWE 45160
606	1-2	1	5 7/8	1 3/4	3 1/2	5 1/8	3/8	1/2	8.125	8 5/8	3.9383	9 1/4	3 7/8	1/2	4	3 5/8	6	9 1/2	8	100 MWE 52180
608	1-2	1 1/8	6 3/8	2	3 7/8	5 1/2	1/2	9/16	9.125	9 5/8	4.3320	10 1/4	4 5/16	5/8	4 3/8	4	6 1/2	10 1/2	8 3/4	110 MWE 56200
610	1-2	1 1/8	6 7/8	2	4 1/2	5 7/8	1/2	9/16	9.750	10 1/4	4.7260	10 7/8	4 11/16	5/8	4 13/16	4 3/8	7	11 1/4	9 1/2	120 MWE 62215
612	1-2	1 1/4	7 1/2	2 1/4	4 7/8	6 1/4	1/2	9/16	10.375	10 7/8	5.1197	11 7/8	5 1/16	3/4	5 1/8	4 3/4	8	11 7/8	10 1/4	130 MWE 68230
614	1-2	1 1/4	8 1/2	2 1/2	5 3/4	7	1/2	9/16	12.000	12 5/8	5.9072	13 7/8	5 7/8	3/4	6	5 1/2	9	13 1/2	12 1/4	150 MWE 76270
616	1-2	1 3/8	9 3/8	2 3/4	6	8 5/8	5/8	5/8	13.625	14 3/8	6.6950	15 1/4	6 9/16	1 1/4	6 3/4	6 1/8	10	15 1/2	13 1/2	170 MWE 86310
618	1-2	1 7/16	10 1/2	3	6 1/4	9 1/8	5/8	11/16	14.750	15 1/2	7.4822	17 1/4	7 3/8	1 1/2	7 9/16	6 5/8	11	16 1/2	15 1/8	190 RM 92

♦MWE DESIGNATES WOUND ROLLER BEARING.
FOR INTERCHANGEABLE SOLID ROLLER BEARING USE LETTERS MTE.

Figure 2—AISE Standardized D-C Mill Motor Back Axle Details.

Fire Resistant Hydraulic Fluids

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. . . . in applying fire resistant fluids it is essential to know the limitations of the particular fluid with regard to the system in which it is installed . . . . factors to be considered are temperature, hydraulic pump design, and a number of operating conditions . . . .

▲ THE desirable characteristics of conventional hydraulic oils are:

1. Correct viscosity.
2. Good viscosity index.
3. Adequate film strength and lubricity.
4. High oxidation resistance.
5. Good water separating ability.
6. Good anti-rust properties.
7. Good resistance to foaming.

A good balanced petroleum hydraulic oil has these characteristics but is not fire resistant.

The petroleum oil normally used as hydraulic fluid is commonly recognized as a flammable material. If it sprays from a broken hose or connection or drips from a leaky seal into a source of ignition, it may ignite. A fire would then result. The seriousness of the fire would depend on the quantity of the oil leaking and on whether there is other combustible material present that may be ignited by the oil fire. Such material includes men's clothing, wooden floors or ceiling beams, cardboard or wood boxes, rags, waste, open oil drums and solvents.

Oxygen is always present since air contains about 21 per cent (by volume). Whether or not a spray of oil from a break or leak in a hydraulic system will burn when it comes in contact with a source of ignition depends on particle size, the amount of air present and the intensity of the source of ignition.

Various interested parties do not always agree on what constitutes a source of ignition. Sources commonly mentioned include a nearby gas flame, pot of molten metal, welding arc, or a slab of red hot metal. Sometimes a sparking commutator at some distance is considered a source of ignition. A suspected source of ignition should be examined with respect to three requirements:

1. It must be so located that a combustible fluid from a leak or break could drip on it or be sprayed on it.
2. It must have sufficient heat capacity to generate a flammable mixture through vaporization of the hydraulic fluid.
3. It must be of sufficiently high temperature to ignite the vapor-air mixture.

With respect to the first of these requirements, it should be realized that many systems employ pressures of 3000 psi and that these pressures can throw a spray of fluid 40 ft or more.

Where a well defined source of ignition is associated with a hydraulically actuated machine or mechanism and cannot be economically removed or isolated, and where surrounding conditions are such that a fire would likely be of serious consequence, the use of a fire resistant hydraulic fluid should be considered. Among surrounding conditions that should be investigated are: (1) provisions for the safety of operating personnel in the event of a fire, (2) the presence of combustible material, (3) the adequacy of fire control, and (4) the presence of equipment and material that may be damaged by a fire.

Certain hydraulic systems are operated in close association with sources of ignition that would be impractical to isolate. Surrounding conditions could be such that a fire which might be initiated by hydraulic fluid coming into contact with the source of ignition, could be hazardous to personnel or could cause a serious fire loss.

We firmly believe that each suspect installation should be investigated to determine whether or not it constitutes a fire hazard. The three things necessary for combustion, combustible material, source of ignition and sufficient air, should be checked. Under some conditions as analyzed for an existing installation or for equipment to be installed, the investigation could reveal that a conventional petroleum hydraulic oil would be satisfactory. Thus the advantages of the ideal product could be utilized to the users benefit.

However, it may be necessary under certain hazardous

conditions of operation to use a fire resistant type of fluid. As a matter of record there are several types available.

A. One type of fire resistant fluid is water. However, water alone lacks several important qualities as an hydraulic fluid.

1. Its viscosity is so low that it has little value as a sealing fluid.

2. It has little or no ability to prevent wear or reduce friction under boundary lubrication conditions.

3. It has no ability to prevent rust.

The shortcomings can be made up in part by the addition of a suitable soluble oil, forming an oil-in-water emulsion. From one to four per cent of soluble oil is usually used.

Soluble oil emulsions are used in some very large hydraulic systems where work-stroke speeds are very low. Examples are large freight elevators, large forging or extrusion presses, hydraulic roll balances, large mill crop shears, etc. Pressures in these systems may be in the 2000 to 3000-psi range or higher. Vertical in line reciprocating plunger pumps with packed plungers are usually used. This type of pump does not require high anti-wear characteristics of the hydraulic fluid.

B. Another type of fire resistant hydraulic fluid is a water-in-oil emulsion (or an inverted emulsion). Some of these fluids now available have good emulsion stability, good anti-rust properties and good anti-wear characteristics in addition to their fire resistance. One of the satisfactory fluids of this type has physical characteristics similar to those of a high quality conventional hydraulic oil. For example:

A viscosity at 100 F Saybolt universal of 320 sec.
A viscosity at 150 F Saybolt universal of 85 sec.
A viscosity index of 157.
A pour test of +15 F.

It contains a high percentage of water for good fire resistance, sufficient film strength to reduce wear, and inhibitors to prevent corrosion in both the liquid and vapor phases.

This type of fluid also has certain limitations but it can be used in systems where the use of an oil-in-water emulsion could not satisfactorily be used.

Inasmuch as it contains water, it should always be stored in closed containers to prevent evaporation. Also, it should not be subjected to cyclic variations of above and below freezing as this may in time affect the stability of the emulsion.

When installing in a system, it is recommended that the hydraulic system be thoroughly drained, cleaned and blown out with compressed air. Then the system should be flushed with a sufficient amount of this fluid to permit circulation before the main charge of the fluid is installed.

Pump gasket and cylinder packing materials made of neoprene, buna N rubber or silicones should be used for hydraulic systems seals. Cellulose types of filters are satisfactory for this type of fluid.

Inasmuch as this product contains water, it is not recommended for use in systems containing magnesium base alloys or where it can contact magnesium in any form.

C. A third type of fire resistant hydraulic fluid may be classified as water-base synthetic. Very satisfactory results have been attained with the use of these fluids and some of the physical characteristics of two of our materials with SSU viscosities of 200 and 300 at 100 F respectively are as follows:

	No. 20	*No. 30*
Viscosity SSU at:		
0 F	3000	5000
100 F	200	300
Viscosity index	160	155
Pour point, F	−35	−25

These fluids depend on their water content for fire resistance and unless the water is removed they can be considered as highly fire resistant. Exposure for long periods at elevated temperatures can cause the evaporation of water, in which case the remaining material is flammable but not to the same extent that are petroleum products. At normal operating temperatures evaporation of water is slow and additions of water to maintain fire resistance need be made only at infrequent intervals.

These water-base fluids have been subjected to many different tests to make sure that they are really fire resistant under a wide range of conditions. Those reported in the following demonstrate the practical non-flammability of these fluids:

Navy flammability tests—In its investigations of fire hazards of high pressure hydraulic systems, one of the tests developed by the Navy for ascertaining the fire resistant character of various fluids was the "spray flammability test." In this test it was found that a fine spray of water-base fluid could not be ignited by an electric arc even when the atmosphere surrounding the spray contained more than three times the per cent of oxygen in normal air; petroleum fluids ignite when the surrounding atmosphere contains only 12 per cent of oxygen.

Spray test—Petroleum hydraulic fluid was atomized by a diesel-injection spray nozzle at 3000-psi pressure. The spray was easily ignited by a small gas flame. The oil burned with almost explosive force. When No. 20 was atomized by the same nozzle and at the same pressure, the resulting mist could not be ignited.

Other tests—These have shown that these fluids have:

1. Excellent low temperature characteristics.
2. High chemical stability.
3. Good wear resistance.
4. No greater tendency to foam than quality petroleum fluids.
5. Practically negligible toxicity.

The proper installation procedures for these fire resistant water-base fluids are as follows:

1. Drain all oil from the reservoir, accumulator, cylinders and piping. It may be necessary to break some pipe joints at the cylinders and at low points in the piping to remove all of the oil.

2. Clean the system as completely as possible. Where the system is relatively clean, it may be sufficient to flush with a minimum quantity of fire resistant fluid. The machine should be cycled a number of times to make sure the flushing fluid reaches all parts of the system. The fluid used for flushing should be set aside in drums. After it has separated from the oil, the fluid may be pumped from the bottom of the drums and used for make-up (heavier than oil).

3. Clean suction filters and renew the cartridges of any full-flow or by-pass filters.

4. Remove any paint from the inside of the reservoirs, unless it is known to be resistant to the fluid to be installed.

5. Remove shaft seals containing cork and replace with seals of neoprene or leather.

6. Repair leaky joints and replace defective gaskets and seals to reduce loss of fluid to a minimum.

7. Where reservoir operating temperatures are consistently above about 140 to 150 F, install a cooler, or remove cause of high temperatures.

8. Fill the system to the proper level with the fire resistant fluid.

9. Maintain the proper water content of water-base hydraulic fluid installed in accordance with an instruction sheet furnished by the fluid supplier.

D. The fourth class of fire resistant hydraulic fluid may be classified as straight synthetic. The water content of such a product is nil. Hence, water balance of this fluid is eliminated. In addition to previous applications mentioned, this type of fluid can also be used in systems with radial type pumps and particularly so where high pressures prevail.

Installation precautions with respect to clean and tight systems and sealing materials for packing are just as important as for water-base fluids.

These fluids are available at higher viscosities than water-base types and hence can be used in systems where greater wear resistant qualities are necessary for high pressure radial type pumps.

SUMMARY

Where fire resistant fluids are considered necessary, it is well to know the limitations of the particular fluid with regard to the system in which it is to be installed.

This includes:

1. Make and type of hydraulic pump.
2. Temperatures involved (high and low).
3. Other operating conditions which may affect maintenance costs and procedures, productive capacity of the system involved and related equipment as well as cost of the fire resistant hydraulic fluid itself.

DISCUSSION

PRESENTED BY

C. E. S. EDDIE, Plant Lubrication Engineer, Great Lakes Steel Corp., Ecorse, Mich.

H. R. IKER, Lubrication Engineer, Socony Mobil Oil Co., Inc., Detroit, Mich.

C. E. S. Eddie: I would like to ask with reference to this missible mixture of water and oil, what work, if any, has been done in the addition of pour point depressants for low temperature operation below freezing point?

H. R. Iker: As you probably remember, I mentioned pour points of certain fluids. We will say, for example, that No. 20 and No. 30 fluid have a pour point of minus 35 F for No. 20 and minus 25 F for No. 30. As we know, it contained water. Water will freeze at 32. So we know that there has been a pour point depressant added (actually a glycol is used).

That is also true in the other types of emulsions, with the exception of the first one I mentioned, where water is used with a very small amount of soluble oil. Therefore, we will say the freezing point of that would be 32.

1958 AISE

SPRING CONFERENCE

April 21, 22, 23

Tutwiler Hotel Birmingham, Ala.

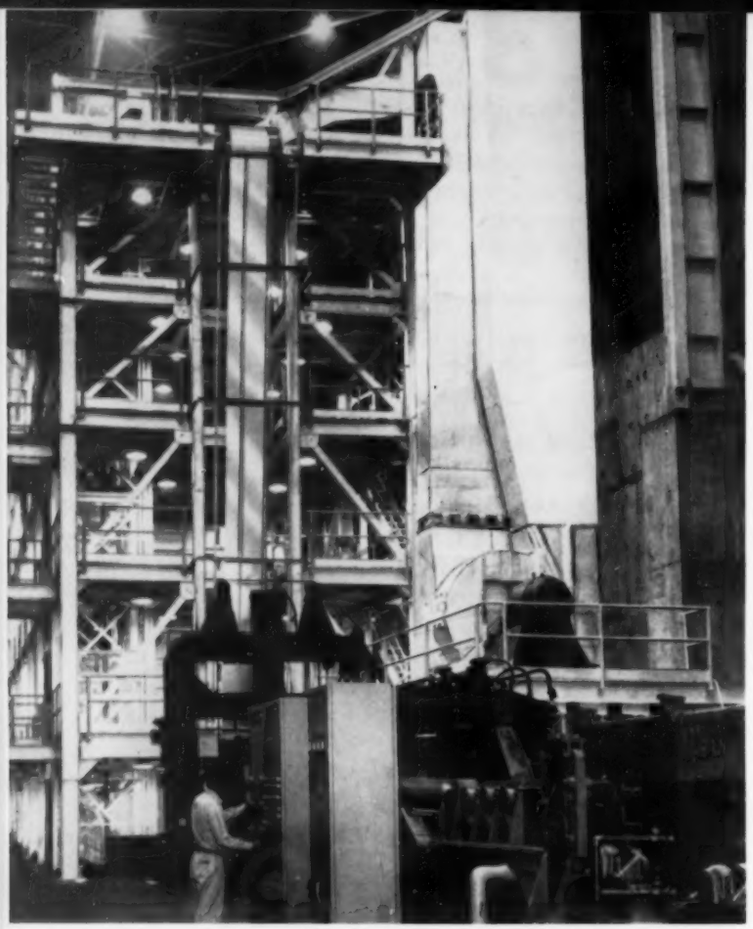

Figure 1 — New No. 3 continuous galvanizing line in the sheet mill department is a five-stack annealing unit having the capacity to handle heavy gages. The strip steel is seen in the figure moving up at the center of the annealing unit, and following annealing it enters the galvanizing pot to be coated with zinc. In the right foreground is part of the cleaning unit of the line which operates at 300 fpm and can produce 12,000 tons per month.

Weirton Steel Places Additional New Facilities Into Operation

▲ A new continuous cleaning and annealing line in the tin mill department and a new continuous coil galvanizing line in the sheet mill department have been recently placed in operation at Weirton Steel Co. division of National Steel Corp.

The continuous cleaning and annealing line, located in a new building that is 560 ft long, 122 ft wide and 110 ft in height, handles 60,000-lb coils of cold rolled strip up to 45 in. wide in tin plate gages, and operates at speeds up to 2000 fpm.

Steel coils from the tandem cold mills go to the new line, which can clean and anneal 60 tons of strip per hr, and from there are transported to the adjacent tin mill buildings ready for skin rolling and electrolytic tin plating.

In the continuous annealing process, it is necessary to provide sufficient looping or slack in the strip at the entry end of the annealing furnace to permit the welding of coil ends without stopping the steel passing through the furnace. Looping must also be provided for at the exit end for alternately changing the winding reels so the line may continue to operate without stopping in the furnace while coils are removed.

Ordinarily this process is accomplished in looping towers above the working floor level at both ends of the line. However, since the new line at Weirton Steel is located on the fourth floor of the new building, the looping towers go down through the building to the basement floor, permitting the looping of 700 ft of strip in each tower.

The tin mill floor is at elevation 730 ft, with adjacent ground sloping toward the Ohio River. The first floor of the new cleaning and annealing building is at elevation 682 ft, making a total height of 48 ft from the first floor to the fourth or operating floor of the tin mill. The new shearing building connecting the tin mill and the new cleaning and annealing building houses four shearing lines.

A 30-ton elevator services all floors of the structure in which the cleaning and annealing line is located. The third floor of the building contains electrical substations and hydraulic, air cleaning and other services, and the first and second floors are used for tin plate warehouse storage. Small fork trucks are used to move material in the warehouse. A 30-ton crane lifts coils and other materials on the operating floor.

The entire structure is carried on

RUST Slab REHEATING Furnaces

TWO TRIPLE-FIRED, END CHARGED, END DISCHARGED, CONTINUOUS REHEATING FURNACES INSTALLED BY RUST IN A PENNSYLVANIA HOT STRIP MILL

heat 160 tons of cold steel slabs per hour

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The outstanding feature of these Rust Furnaces is the completely automatic temperature and combustion control, with easy operation from a centrally located panel board. Slabs are heated in two triple-zone gas furnaces. Burners at top and bottom heat slabs to rolling temperature at a rate of about 160 tons of cold steel per hour (80 tons per furnace). Furnace temperature ranges from 1650°F. at the entry end to about 2400°F. at the discharge end.

Flexibility is achieved by simply changing the fuel firing rate in the heating zone. The result is HIGH TONNAGE OUTPUT with MINIMUM FUEL CONSUMPTION. Aiding this high capacity and economy of operation are Rust Recuperators which preheat the air for combustion. This type of Rust Furnace is used by virtually all of the strip mills in the world. Rust also builds all other types of metallurgical heating furnaces (designed for any fuel). For either new or modernization projects let Rust quote on your requirements.

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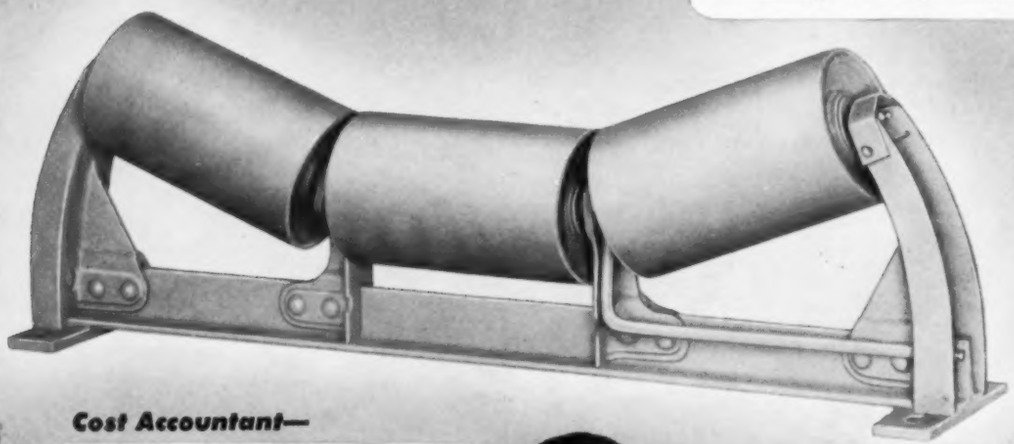

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Sturdy rolls of the Series 100 are accurately machined for concentricity—welded for added strength and to keep out dirt and moisture. Smooth, round surfaces and edges prevent belt damage. As for dependability of its roller bearings—Link-Belt has *never* known a bearing failure due to overloading a Series 100 idler. Equally important, strong malleable iron brackets and sturdy, rigid frames maintain accurate roll alignment.

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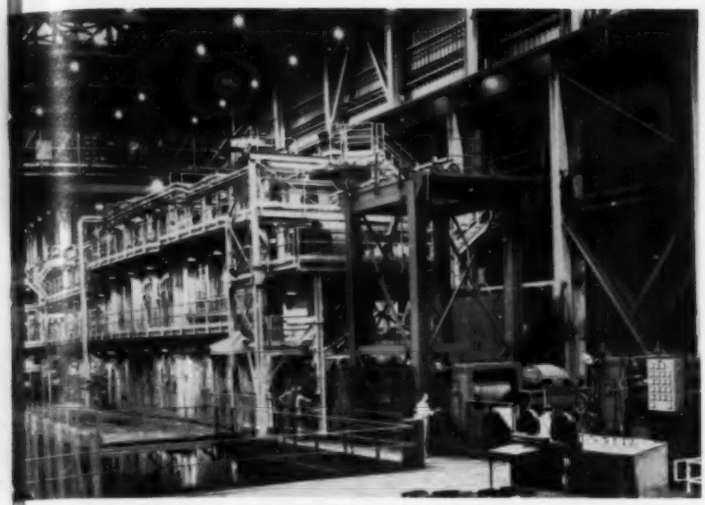


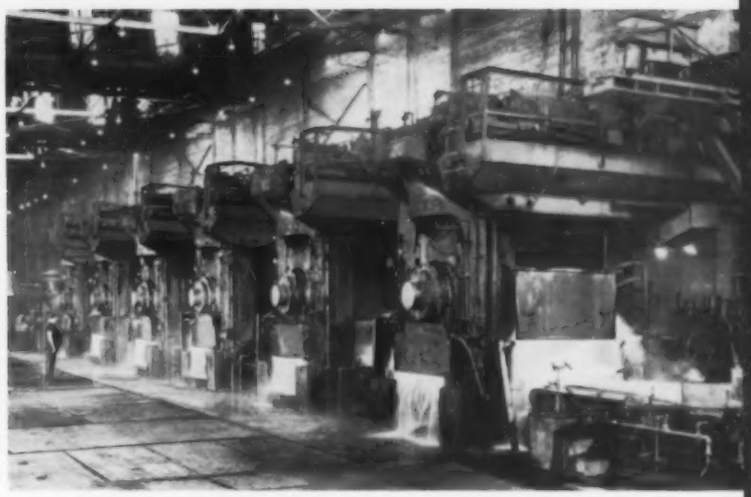


Figure 2 (left) — Annealing section of the new continuous cleaning and annealing line in the tin mill department. After traveling through the cleaning section of the line (located at the rear of left section of figure) the steel strip moves in vertical loops through heating, soaking and slow cooling sections in the annealing unit and is then rewound into coils. The line operates at 2000 fpm and can clean and anneal 20,000 tons of steel for tin plating per month. The new line makes continuous operations possible from the time a hot slab enters the roughing train in the strip steel department until the finished tin plate is ready for shipment. Figure 3 (right) — These six four-high finishing mills in the strip steel department have a capacity of 2,640,000 tons of hot strip per year. The strip as it leaves the mill may travel as fast as 2400 fpm.

concrete foundations supported on rock base, with column loads approximately 4,000,000 lb each.

The building, constructed of insulated panel, is designed for the future addition of two more continuous cleaning and annealing lines.

The sheet mill department's new continuous coil galvanizing line is designed to operate at 300 fpm maximum and is capable of producing galvanized steel in widths from 18 to 48 in. It was also announced that a second similar line is now under construction.

The new lines, which are of the latest design, will make a total of four continuous galvanizing lines at Weirton Steel.

To accomplish the installation of the new lines, a retaining wall 40 ft high and 1045 ft long was constructed and so designed that the base of the wall forms part of the galvanizing line substation foundations.

A high-bay building was constructed to provide the necessary housing and service space required for the furnace area and the entry end of the lines, while a low-bay building houses the delivery end. The entry end of the building is 58 ft high to the crane rail by 517 ft-6 in. long, and adjoins the delivery end building which is 20 ft-1 in. high to the crane rail by 270 ft long. Both buildings are 67 ft-6 in. wide.

The area below the mill floor for the full length of the buildings is designed as a basement to house the necessary electrical equipment, switch gear and substations to operate the lines.

Cleaning solution storage and equipment and hydraulic supply rooms are located in the basement which also provides for looping cars that travel approximately 200 ft on either side of the furnace. The sub-level below the basement is designed as air ducts to properly distribute clean air to the various units.

Steel in coil form is received at the new galvanizing lines direct from the strip steel department tandem cold mills and is sized and cleaned before it enters the preparation furnace which is a multiple horizontal pass unit, 90 ft long by 54 ft-4 in. high.

As the strip emerges from the furnace, it is given a hot dip of zinc coating and then travels vertically 47 ft-7 in. to a coooling tower where cool air is blown over the surface to reduce the temperature. The travel of the strip then is directed back near the floor line where the metal receives further required processing and can be taken from the lines in either sheets or coils.

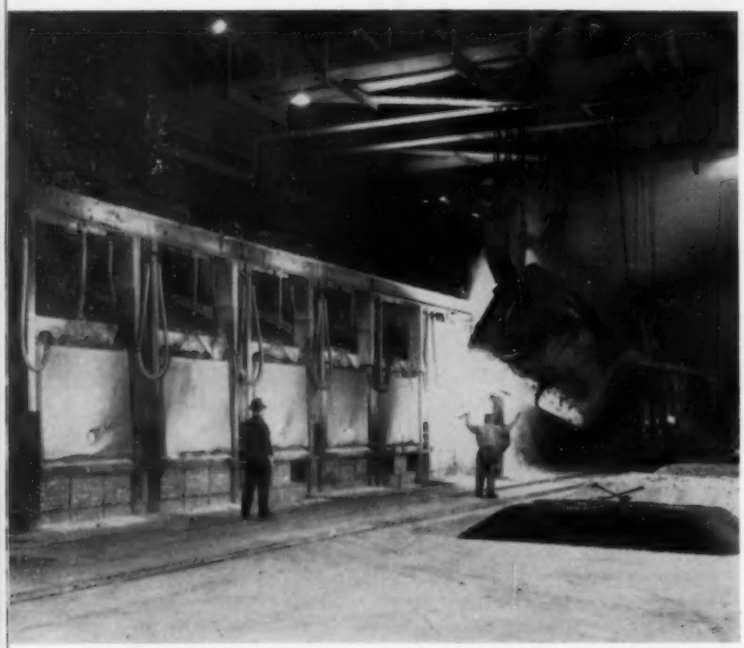
In conjunction with the installation of the galvanizing lines, a 382 ft-6 in. addition was added to an existing shipping building. Also provided is a 122-ft wide by 291 ft-3 in. long coil storage building which provides space for storage of coils ahead of the lines and also houses a new slitting line which is used to further process coils to customer requirements.

As a part of the new sheet mill installation, other new buildings were constructed to house the required associated equipment to produce the neutral gases and other services required for operation of the lines.

The new continuous galvanizing units are only part of a major expansion program at Weirton. These improvements also represent an important part of National Steel Corp.'s total capital expenditures of $377,467,675 during the period 1952–56. In addition to this figure, which includes improvements in existing facilities and investments in raw materials companies, it is estimated that $85,000,000 to $90,000,000 more will be spent in 1957, making National Steel's total capital expenditures from 1952 through the end of 1957 nearly $500,000,000.

Expansion of 1,000,000 tons in annual ingot capacity and additions and improvements in finishing operations are included in the program, and by 1958 the ingot capacity of National Steel will have increased from 6,000,000 to at least 7,000,000 tons per year.

The general program at Weirton Steel Company division since 1952



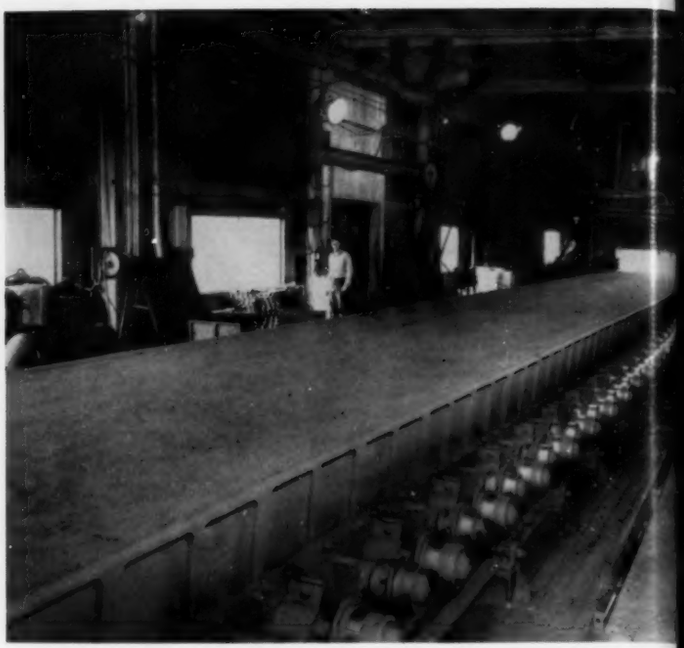


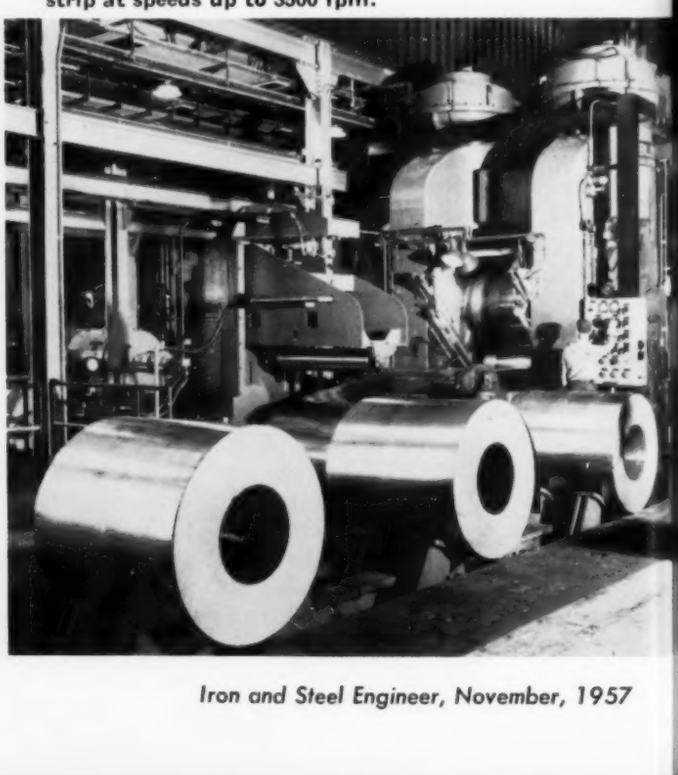
Figure 4 (left) — The world's largest open hearth furnace, with a capacity of 600 tons per heat, receives hot metal. National Steel has pioneered in the development of the large open hearth furnace, and of its total of 31 furnaces at Weirton Steel and Great Lakes Steel Corp., 18 have capacities of 500 tons or more. Weirton Steel Co. operates a total of 14 furnaces. Figure 5 (right) — Bed of the sinter plant is constructed of a series of pallets that have grate bars for a bottom and are 8 ft wide and 32 in. long. Placed end to end and traveling over an endless track, the pallets form the working bed which is 104 ft long, 8 ft wide and 14 in. deep. This plant produces 2600 tons per day, and a second sinter plant, now under construction, will have a bed 12 ft by 147 ft with a capacity of more than 5000 tons of sinter per day.

has included two new coke batteries, making a total of six in operation. This was an addition of 82 ovens, making a total of 294 ovens to produce 5200 tons of coke. With these additions came an increase in the storage space for coal and changes in the by-products plant to take care of increased production. A new phenol plant, which replaced an earlier plant, is the only one of its type in the country and is notable for its high efficiency in removing phenols from water that is returned from the Company's operations to the Ohio River.

The program also included construction of a blast furnace in 1952 (making a total of four) and with it a new blower room to house two turboblowers (making a total

Figure 6 — The No. 7 cold reduction tandem mill operates at 7000 fpm and can reduce 60,000-lb coils of steel. The mill is one of five cold reduction tandem units at Weirton Steel.

Figure 7 — The No. 8 temper mill (skin mill) in the strip steel department is the largest addition to the company's operations for temper rolling. A four-high, single-stand mill, it can process 30,000-lb coils of steel strip at speeds up to 3500 fpm.



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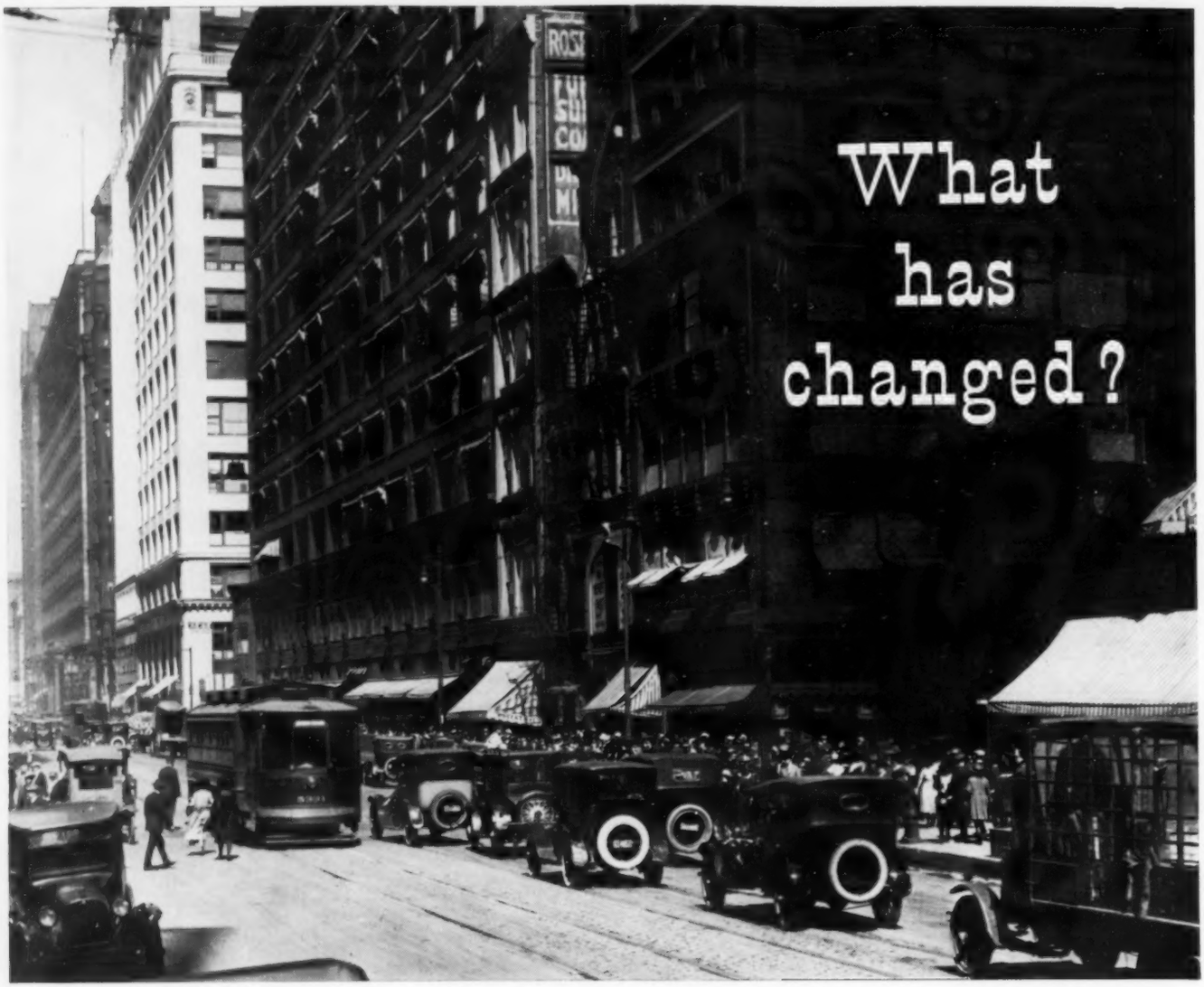

The automobiles of today are certainly different than the models shown in this photo of downtown Chicago. Many other things have also changed since this picture was taken.

One thing that remains unchanged – as it has for the past 36 years – is the remarkable spirit of service that has guided THE CHICAGO CONCRETE BREAKING COMPANY (recently re-named THE EDWARD GRAY CORPORATION) to its commanding position in modern demolition and construction. Here is skilled know-how and experience . . . designed to save you both considerable down-time and money on your emergency repairs, rehabilitation of present facilities, or new construction.

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of six). The program has also included a new ore yard (total 2), a new ore bridge (total 4) and a belt conveyor to supply ore to high level lines and to the sinter plant which was also constructed during the past five years. The sinter plant has an 8-ft-wide bed, and a second sinter plant, with a 12-ft-wide bed, is under construction.

The world's largest open hearth furnace, with a capacity of 600 tons, was recently constructed and placed in operation. Installation of this unit, the 14th open hearth furnace at Weirton Steel, required a 120-ft extension to the existing open hearth shop, making the length of the open hearth building 1340 ft. A new ladle crane of 550,000 lb capacity was installed, making a total of five ladle cranes. A new mixer crane was installed (making a total of two) and a bessemer converter, which will make a total of three, is also under construction.

At the river docks, a new loading dock with warehouse and railroad tracks was installed. A new coal hoist, now under construction, will be a duplicate of the present hoist which has been modernized during the past five years. The pumping station has been enlarged through the addition of a new wing to accommodate new equipment, and its capacity has been increased from 146,000 to 234,000 gpm.

In the blooming mill, the soaking pits were reconstructed to make them more modern and efficient. A new 15-ton soaking pit crane was installed to replace a smaller one, making a total of two 15-ton cranes, and a new stripper replaced an old one, giving this department two modern strippers. A gantry crane and a desurfacer (scarfer) were also added.

The general construction program in the 54-in. strip steel department includes the fastest hot sheet rolling mill of its size (almost 2400 fpm), the world's speediest cold reducing tandem mill (rated at 7,000 fpm), the industry's largest reheating furnaces (three of them with rated capacities of 200 tons of 26-ft-long slabs per hr each), and the widest slab yard (128-ft span). A scale-handling system collects scale from the new hot strip mill and a high-pressure water system flushes the scale and keeps it moving to a central collection point. A 72-in. sewer line 3000 ft long was also installed. A new 900-ft conveyor loop moves coils of steel from three mandrel-type down coilers at the exit end of the hot mill. A new pickling line, 665 ft long, has a delivery speed of 750 ft of steel strip per min. A sheet-packaging conveyor was installed, a new elevated locker room was built and a speedwalk similar to an escalator was installed to take employees from the mill floor to the locker room level. The hot strip mill building, 1800 ft long and constructed of insulated metal panels, has an 80-ft-high roof.

The program in the tin mill has also included a new electrolytic tin plating line (there are four lines for tin plating and one for zinc plating), three new cutting lines for tin plate (making a total of 10) and one cutting line for zinc coated plate. Box anneal capacity was increased with five new furnaces which required a building extension 174 ft long and 81½ ft wide serviced by a new 60-ton crane. One new temper mill was also put into operation, making a total of four.

During the expansion and improvement program, the use of electronics equipment grew so rapidly and became of such importance to operations that an electronics department was established in 1955. This department has directed installation of and maintains audio amplifier systems, two-way radio communication systems on the company's trucks, on the company's river boat (the Weiriter) and on railroad engines, carrier radio communication systems on cranes, high power radio induction heating systems on the electrolytic tin plating lines, electronic scales for weighing steel, photocell amplifiers for detecting holes in tin plate, x-ray gages to measure the thickness of strip at the 54-in. hot mill and contact gages to control prime and off-gage products at the cutting lines, tandem mills and temper mills. In addition, another recent installation is a closed-circuit television system used to control the furnace charging operation and the runout tables of the 54-in hot mill. Closed-circuit television is also used at scales in the steel works to determine the contents, conditions and the number of cars being weighed.

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This plating tends to make the brick more resistant to spalling. The metal in the plate oxidizes and combines with the refractory, bonding adjacent bricks together and materially increasing their life even under the severest conditions of service.

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▲ TIMKEN'S new Bucyrus shipping center is part of a highly integrated system representing a new approach to inventory control, production scheduling, storage and the processing of customers orders. Designed and built within a year's time, the shipping center now handles 95 per cent of the Timken Co.'s bearing shipments. Over 10,000,000 pieces are handled and shipped each month by the packaging and handling equipment in the highly mechanized warehouse.

The decision to build the new center was made in September of 1955. Ground was broken by October of that same year and the center was in operation by July 1, 1956. It has 140,000 sq ft of floor space and approximately 12 to 15,000,000 cups and cones are kept in stock at all times. This represents about a month's supply of bearings at the present rate of use.

The other important tool in this system is the IBM 650 computer located in the Canton, Ohio, office. The major task of the computer is to keep track of inventory, scheduled production and unshipped customer orders. This makes it possible to determine quickly whether or not a customer's shipping date request can be met.

In addition to the computer there are many other modern office machines which, when linked together, make a completely integrated system.

Throughout the system the technique of integrated data processing has been used. This means the making of a record in such a way that other related records can be made from it with a maximum use of machines and a minimum of manual effort.

Before the new system was put into operation, each manufacturing plant had its own shipping department. Orders received in Canton were routed to the proper plant. If it was a split order, one that requested several different sizes, the customer might receive bearings from several different plants. If one shipment was late, the customer had to hold the entire order until the pieces arrived. The shipping center eliminates this problem since the order is shipped from the one location. No part of the order is shipped until the entire order is on hand.

Product is received and stored by a system of conveyors, lift trucks and special equipment. In addition to making the work easier for the employees, it greatly speeds up the process of handling. Pallet unloaders, special lift trucks, packaging equipment and conveyors are an essential part of the center.

A total of 223 employees operate the shipping center. Despite the fact that all but a few of the employees are new to the Timken Co., the center is now functioning smoothly after a year's operation.

The entire system was designed with one major goal in mind—to provide better service to customers. The advantages to the customer include a reduction in the time needed to receive and process an order.

From the Timken Co.'s point of view the system has greatly improved manufacturing and inventory control. Now possible is a

Figure 1 — An aerial view shows the Timken Co.'s Bucyrus bearing plant in the foreground and the Bucyrus shipping center in the background. Located between the two plants is the recreation park. The company invested nearly $12,000,000 in the development of its new high production bearing plant. The annual production capacity is 33,000,000 cups and 27,000,000 cones.

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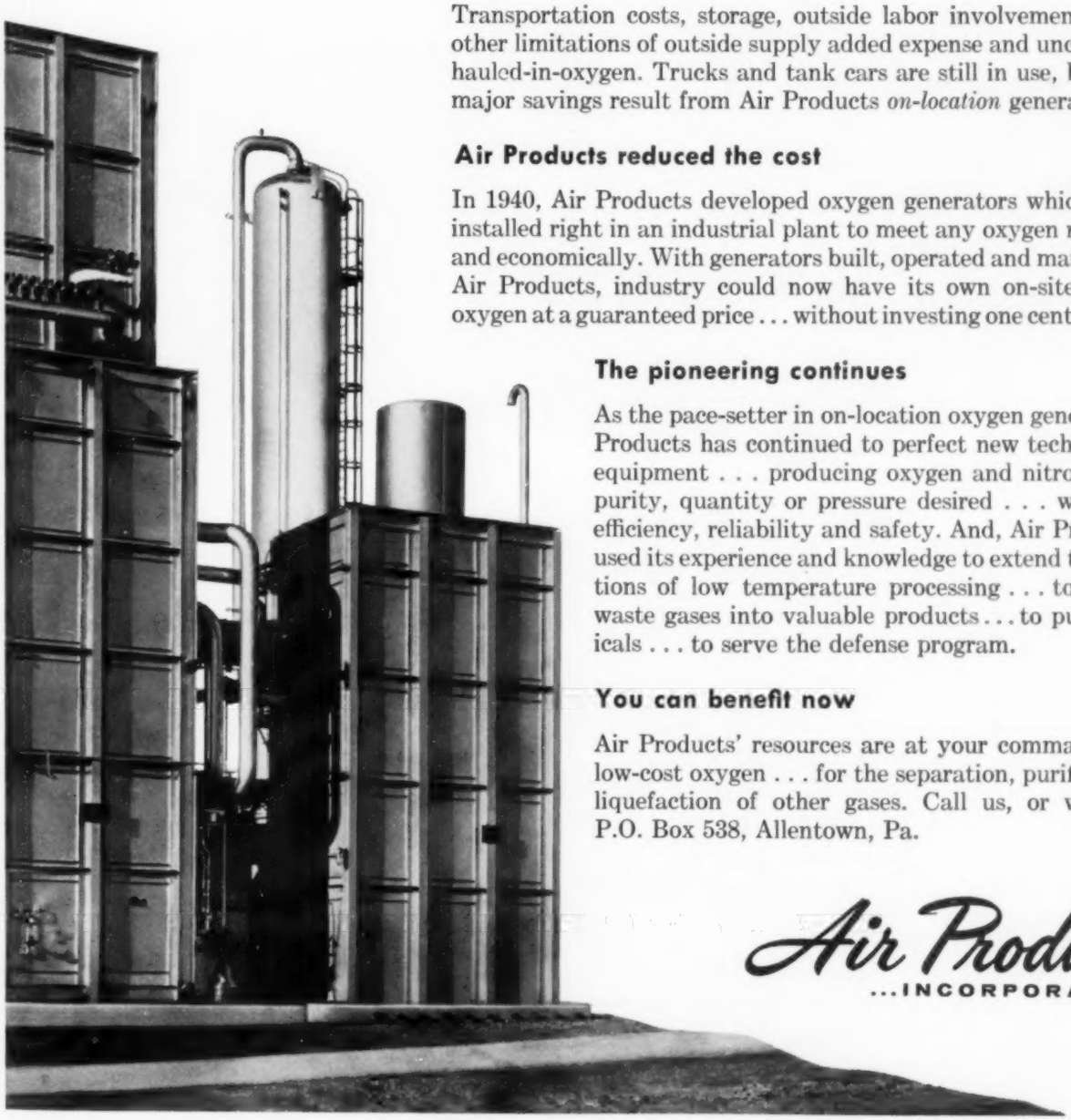

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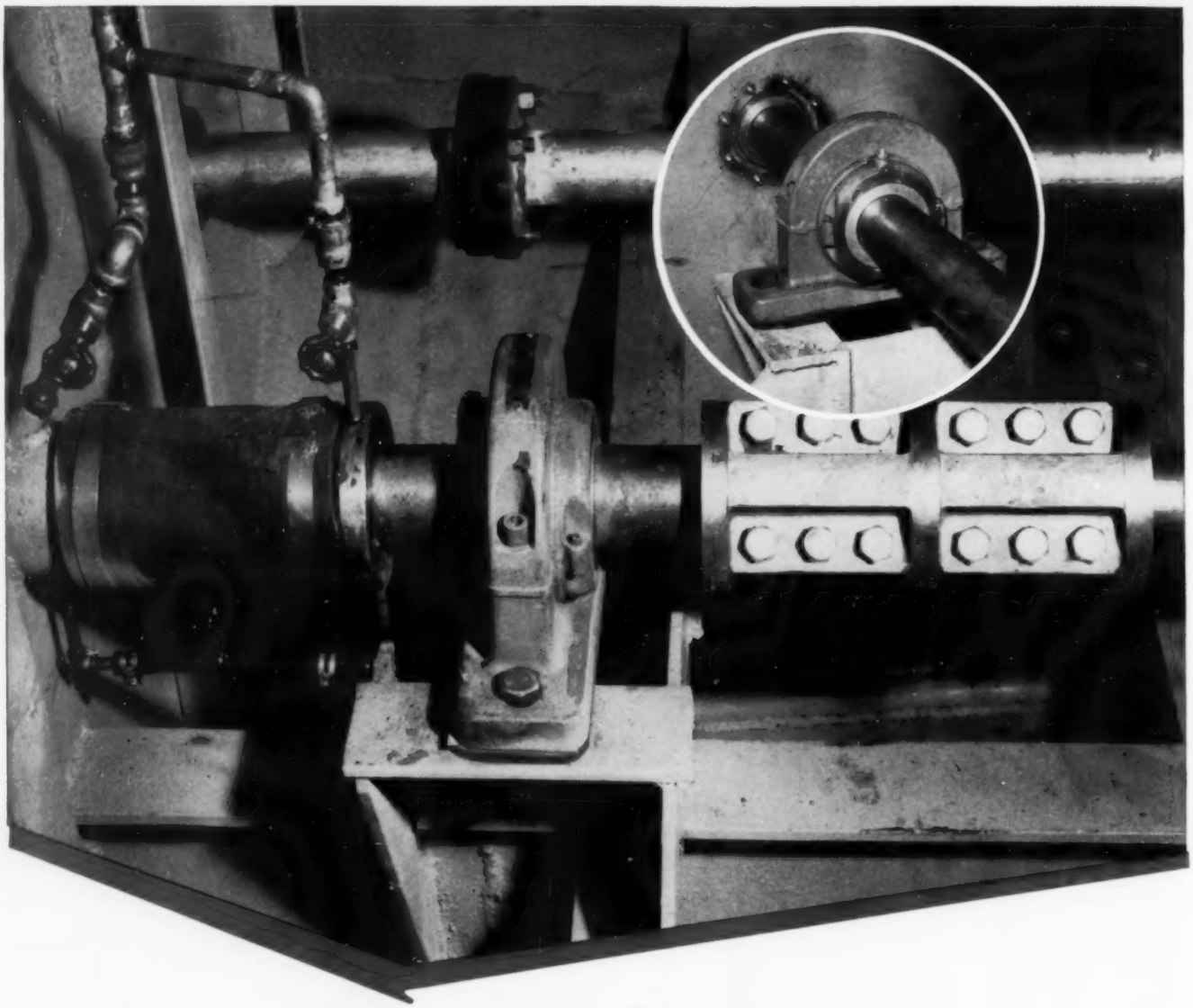

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INDIANA: Ft. Wayne • Indianapolis • Muncie • Terre Haute
PENNSYLVANIA: Erie • Johnstown • Philadelphia • Pittsburgh • York
WEST VIRGINIA: Charleston • Huntington • Parkersburg • Wheeling
NEW JERSEY: Camden • **MARYLAND:** Baltimore
DELAWARE: Wilmington •
Subsidiaries: Balanrol Corp. • Buffalo, N.Y.•
In the South • Dixie Bearings, Inc.

reduction of lead time required for manufacturing schedules and the scheduling of production in economic lots.

The IBM 650 Computer—The major job for the IBM 650 computer is to keep track of inventory, scheduled production and unshipped customer orders. Whether or not a customer's requested shipping date can be met is determined from information delivered by the computer.

The information that goes into the computer is:

1. The previous day's balances of pieces on order, pieces in inventory and pieces scheduled for production.
2. Pieces placed in inventory on that day.
3. New orders received that day.
4. Changes in existing orders.
5. Orders to be shipped in the near future for which pieces have to be allocated.
6. Changes in manufacturing schedules.

The answers from the machine as punched on IBM cards are:

1. Orders to be shipped in more than 14 days.
2. Orders for which pieces have been allocated that day.
3. Unallocated orders.
4. New balances of orders, manufacturing schedules and inventories.

These answers ascertain the situation at the close of each day showing what will have to be shipped and how many pieces are on hand or expected to be on hand so shipments can be made. The IBM 650 requires less than two seconds to calculate all the answers for an item.

A scheduler's reference report is prepared each day which shows pertinent data on every inventory item. The data includes: pieces on order for the current and next four months, the number of pieces in inventory, manufacturing schedules which may be past due, or are for the current month and the next month.

Every item has two numbers to describe it. They are the Timken bearing part number and the item number. The item number translates the Timken bearing part number into a "language" that can be used in the computer, by the shipping center and throughout the entire system.

The IBM 650 computer consists of three units linked together electrically.

1. The punch card unit "reads" the punched holes of the input IBM cards and punches the answers into output IBM cards at the rate of 100 to 200 cards per min.
2. The console unit contains a magnetic drum which is the "memory" of the computer. On this drum, which is 4 in. in diam and 16 in. long, are 2000 magnetized spots. Each of these locations can record a ten digit number and whether the number is positive or negative.
3. The power unit is the link between the console and the read-punch unit. It translates the holes of the punched card into the language of the computer and does the reverse for the computer outlet.

The information fed to the computer is gathered by a newly created sales planning department. This department consists of three sections; the order entering section, the schedule-allocation section and the customer relations section.

The order entering section—of the sales planning department enters the customer's order and issues shipping papers to the Bucyrus shipping center. Conve-filers, cardatypes and multilith machines speed the process.

The four conve-filers contain information on each customer including the size of the bearing ordered, the type of packaging required, etc. The files are powered so any drawer can be positioned quickly in front of the operator.

From the conve-filer the operator removes the IBM prepunched cards containing the following information:

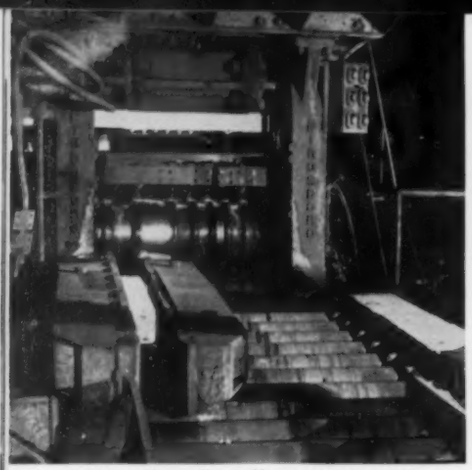
1. The customer "sold to" name and address.
2. The "shipped to" name and address.
3. Terms of sale, that is, cash discount and payment date.
4. The part number ordered, shipping instructions and sales analysis information such as type of business (new, old, experimental).

These IBM cards and the customer's order go to a cardatype unit consisting of the card feed unit, the auxiliary keyboards, the key punch and a special electric typewriter. From the customer's order and the prepunched IBM cards an order form and new IBM card is made. The cards go to the computer.

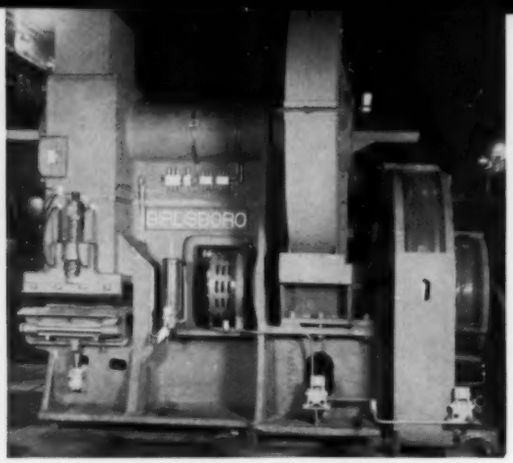
To do this the IBM cards from the conve-filer are first processed through the card feed and read unit. They are "read" and the information is automatically typed by the special typewriter on the order form. Simultaneously in the key punch a new IBM card is punched for each item on each shipping date.

The auxiliary keyboards are used to enter variable information of the

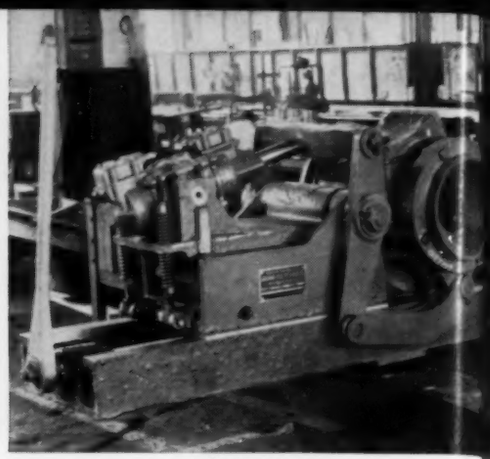
Figure 2 — Six automatic gages, visual inspection tables and cone assemblies handle the production of the five cone lines. Natural light was used to get the shot showing how well the plant is lighted.



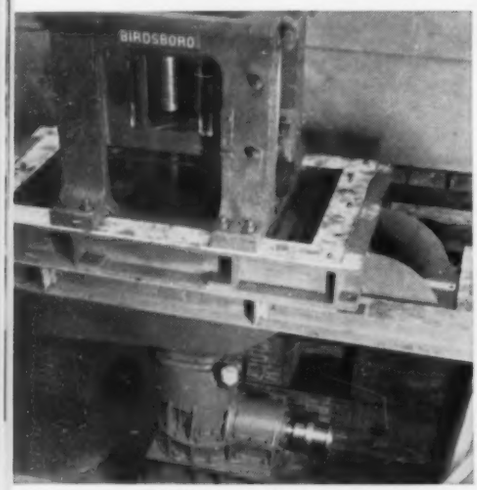
20''—18''—14''—12''—10'' Combination Mill



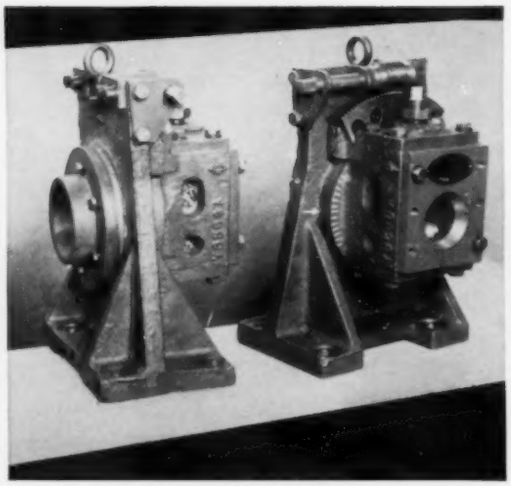
300-Ton Cold Shear



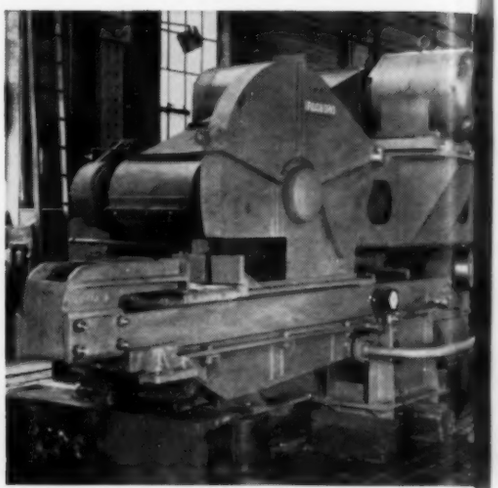
18'' Mill Bar Turner



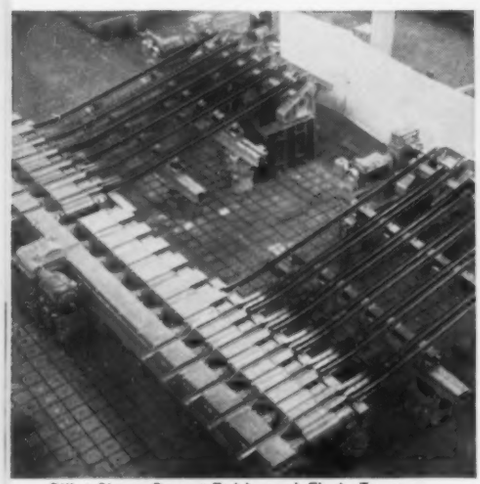
10'' Vertical Mill



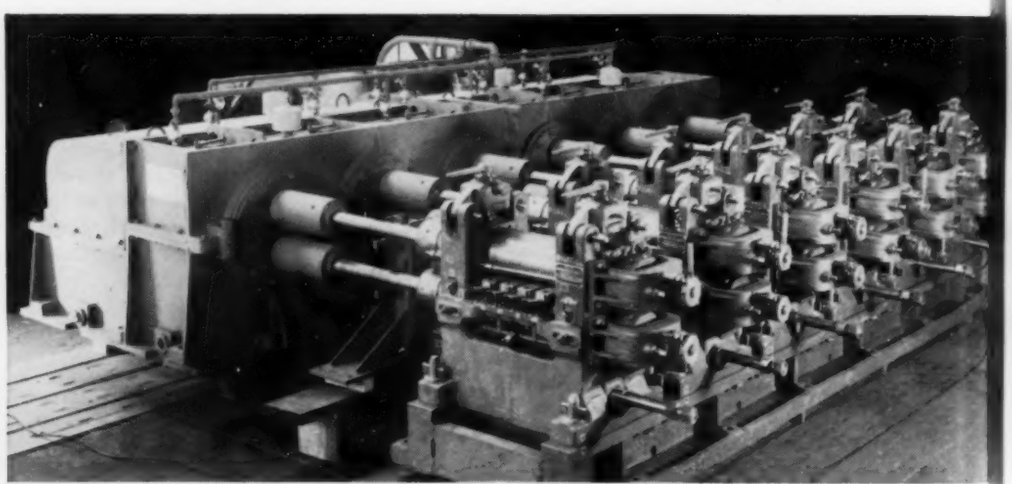
Two Oval Twisters



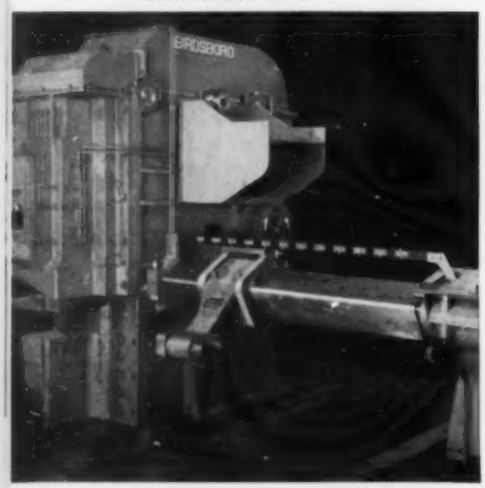
54'' Hot Saw



Billet Shear Runout Table and Chain Type Billet Transfer Beds



10'' 6-Stand Continuous Rod Mill and Drive



350-Ton Up and Down Cut Shear and Gauge

In a customized unit or a complete mill—
skill, imagination, precision mark every job by

MM62-57

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STEEL MILL MACHINERY • HYDRAULIC PRESSES (Metalworking and Extrusion) • CRUSHING MACHINERY • SPECIAL MACHINERY • STEEL CASTINGS • Weldments "CAST-WELD" Design • ROLLS: Steel, Alloy Iron, Alloy Steel

order form and on the new IBM cards. That information is usually in regard to order number, quantity and shipping date.

The special typewriter completes the order form from the information given to it from the permanent IBM cards and from the auxiliary keyboards. It also has a keyboard of its own permitting the operator to add the customer's purchase order number and the method of shipment.

The schedule-allocation section—determines whether or not a requested shipping date can be met. They review and adjust the manufacturing schedules prepared by the computer. Allocations can be made manually in event of an emergency order. Customer numbers and item numbers are also issued by this section.

The customer's relations section—maintains the Canton office's only record of a customer's order. They initiate changes in a customer's order, handle customer and field office contracts and release shipping papers.

Pieces allocated are recorded on the record card which was a part of the original order form. When the allocated portion of the order is ready for immediate release, the clerk prepares an "invoice variable" from the record card. On the invoice variable is the information pertaining to the shipment as to quantity, plant making the shipment and shipping date.

The invoice variable is then matched to the order master. The order master was the first copy of the order form prepared at the card-a-type.

The order master and the invoice variable are on a special paper that can be used to produce copies on the multilith machine. Using these, the operator prints the necessary shipping papers.

These shipping papers and the corresponding IBM allocation cards are sent to the Bucyrus shipping center in special portable metal files. The files are sent on Timken Co. trucks which daily carry finished bearings produced at Canton to Bucyrus.

THE SHIPPING CENTER

The new shipping center is a one-story building 560 ft long and 240 ft wide providing 140,000 sq ft of floor space. There are six receiving docks, 12 truck loading docks and two railroad loading docks.

All bearings and parts are transported by truck and arrive at the shipping center on pallets. Timken Co. trucks make regularly scheduled runs to the center from the various production plants.

The storage area is divided into three sections for pallet, box and bin lots. Full pallets, consisting of the same part number, are stored in the pallet section. The box area receives full boxes and the bin area is used for storage of the less-than-full-box lots.

A lift truck unloads pallets from vans at the receiving docks. Full pallets, those of the same part number, are taken by the lift truck directly to the pallet storage section. Mixed pallets are placed on the conveyor by the lift truck and moved to the pallet unloader which mechanically unloads the boxes and stacks the empty pallets.

The unloaded boxes pass the IBM key punch operator. The operator controls the pallet unloader and conveyors that lead to the storage areas.

There is an IBM location card for every vacant space in the storage area. The IBM key punch operator punches the item number and quantity in each box on the IBM location card. The card is slipped into the end of the box where it can be easily seen. All the cards are sorted according to aisle location. This permits the box lift truck to pass down the aisle one time and still place all the boxes.

After the location cards have been inserted, the boxes move to one of three switches to be directed to a chain floor conveyor serving only the box storage area. The key punch operator can direct the flow of boxes from her station by means of electric buttons.

Once in the aisle the boxes are lifted by the box lift truck from the chain floor conveyor and placed in the proper location as indicated on the card. The operator checks the pieces per box, the item number and the location card against the box label. The location cards are taken to the shipping center office and placed in a tub file.

Each space in the three storage areas has a 7-digit location number consisting of three parts. The first two numbers identify the row. The second group has three numbers and represents the section in that row. The third group has two numbers and indicates the bin in the section.

Product stored in pallet lots are handled by lift trucks and not by conveyor. The pallets are assigned a location in the same manner as the box lots.

Less-than-full-box product is routed to the bin storage area by the key punch operator at the conveyor. No conveyors run through the bin storage area. The pieces are placed on small trailers to be pulled by electric scooters to the right location. Location, again, is assigned in the same way as for box lots.

Before the location cards are placed in the tub card file at Bucyrus, duplicate cards are made and sent to Canton. These are used in the 650 IBM Computer as inventory receipts.

Since random storage is used for the pallet and box sections, completely unrelated products may be found in adjoining spaces. The random storage system permits more flexibility and a greater utilization of space. Permanent bins are kept for less-than-full-box lots.

The allocation cards received from the Canton sales planning department are filed at Bucyrus according to the date shipment is to be made. The cards are sent from Canton along with the invoice master, work copy and contents slip.

The allocation cards are used to select the location cards for the pallets, boxes and bin product needed to make the shipments. Marked on the location card, now called the "picking ticket," is the number of pieces, the packing line and station where they will be sent and the packaging code number.

Picking tickets are arranged according to location in the aisle and placed in a holder at the head of the proper aisle. The operator can pick the product in one pass down each aisle.

All picking and transfer of product to the packaging department is done on the midnight shift. The two day shifts are responsible for storing, packaging, packing, shipping and billing.

Packaging and packing at Bucyrus refer to entirely different operations. Packaging is wrapping of product in treated paper and placing

it in cartons prior to being packed into containers or boxes for outside shipping.

Picking the product is essentially the reverse of the storage method. Box lots are lowered to the floor chain conveyor by the box lift truck. Bin lots are transferred to a conveyor in tote pans loaded on small trailers and pulled by an electric scooter. The picking or distribution ticket is placed on each pallet, box or bin lot as they are pulled. All box or bin lots travel by conveyor to the central transfer station to be distributed to different packaging or packing areas.

Box and bin lots that require special packaging, as ordered by the customer, are routed from the transfer station to that area. Bench loaders sort the product to one of the 35 packaging benches along with a supply of cartons and wrapping paper. All product is pulled and moved during the midnight shift with packaging, packing and shipping completed on the day turns. When the morning shift arrives the benches are full of product ready to be packaged.

Although some small orders are packed by hand, most of the special packaging is completed by automatic cartoning machines. These machines are capable of wrapping and cartoning 22,000 pieces in an eight-hour shift.

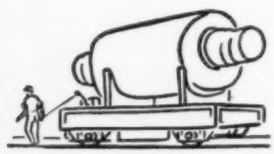
Shipping papers, representing a customer's order for which product is being picked, are taken to the packing benches at the beginning of the midnight shift. Product is routed to the standard packing benches via the transfer station. The bench loaders, sorting orders according to the picking ticket, place them on one of the four sections of a packing bench. He checks the shipping papers against the product on the bench making certain the complete order is on hand, and places the shipping papers with the order. This is done on the midnight shift.

Order packers on the day and afternoon shifts place the product in outside containers for shipment to domestic customers. The packer records the shipment by completing the work copy and contents slip of the shipping papers. The contents slip goes into the front of the first box of the order. The customer's name, address and other data is stenciled on the outside of the shipping container. When all boxes of an order are packed they are moved by roller conveyor to the weighing and banding station.

Before a shipment goes on a truck, it is banded, demagnetized and weighed. Portable, roller conveyor units can be placed directly into the trucks making loading easy and quick. Heat curtains are used at the loading doors during the winter to prevent the building from becoming cold.

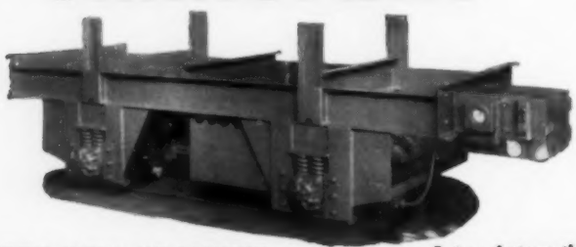
Due to careful scheduling and to the handling equipment of the Shipping Center, orders are completed at a predetermined time regardless of how many different sizes may be on the order. The trucking firm is notified in advance avoiding long wait. Orders are arranged on the 16 packing lines according to the carrier. The truck simply pulls up to the dock and his entire order can be loaded immediately by conveyor or lift truck.

HANDLES THE BIG LOADS WITH BIG SAVINGS



100-ton Battery Operated

ATLAS *Safety Type* TRANSFERS



5-ton Automatic Controlled

ATLAS SAFETY-TYPE TRANSFER CARS can be provided in almost any capacity for storage battery, diesel or gas-electric, or cable reel service.

They are safe because there is only one control lever, and the car moves only when the operator holds the lever.

Request "Walk-Along" Bulletin 1283.

ATLAS CAR & MFG. CO.
1100 IVANHOE ROAD
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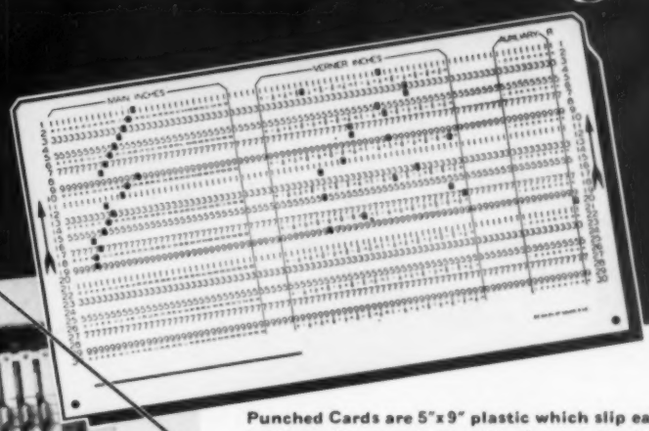
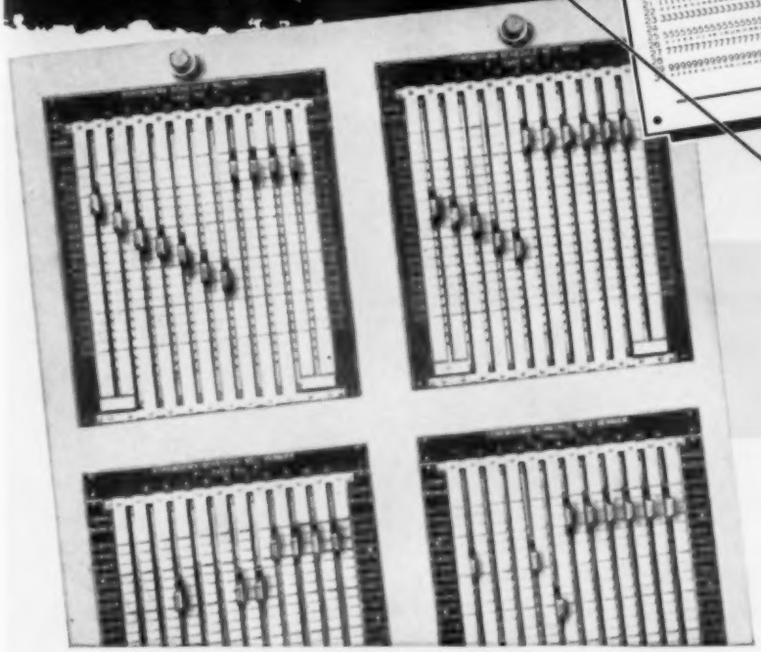
ENGINEERS AND MANUFACTURERS SINCE 1896

Your choice of Automatic rolling—

from EC&M PUNCHED CARDS...



Punched Cards are 5"x9" plastic which slip easily into the card-reader to provide the proper signal for each pass. Indexing is automatic for the complete schedule.



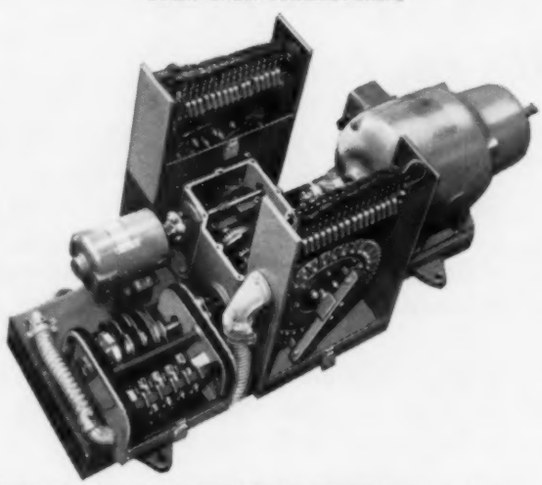
Complete schedules are easy to set-up on EC&M Slider Contact Panels.

...or SLIDER CONTACT PANELS

The EC&M Automatic-Positioning Screwdown Control permits a mill to be operated at full capacity. This system of control has been operating successfully for 20 years, giving a high rate of production with products rolled to close tolerances. Nearly 50 installations use this EC&M Automatic Control.

Rolling operations may be automatically programmed by either one of two EC&M methods — the Punched Card Method or Slider-Contact Panels. Both systems are direct reading for ease of set-up. Each is simple, and since there is no coding or de-coding requiring a multiplicity of relays, servicing may be done by a regular maintenance crew.

To learn how the EC&M Screwdown Control System may be applied to your rolling operations, write our nearby field office for a copy of new Bulletin 6550 describing the Punched Card and Slider-Contact Panel systems of automatic rolling.



EC&M Roll-Position Sensing Unit is simple and compact—controls roll movements from pulpit or control room—up to 1,600 settings per pass permits small increment roll-settings.

Write for EC&M Bulletin 6550

THE ELECTRIC CONTROLLER & MFG. CO.

A DIVISION OF THE SQUARE D COMPANY

CLEVELAND 28 • OHIO

EC&M'S 60TH ANNIVERSARY (1897-1957)

9305

ROLLWAY THRUST BEARINGS...

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Size in Rollway Thrust Bearings—big or little—is a mere matter of operating "geometry" and of the machinery to produce it. But design, precision and quality are dimensionless quantities that vary widely according to loads, speeds, temperatures . . . yet in the end sum up to a single constant: *"To do the job required in the one best way."*

Of course, we're proud of this 2¼ ton bearing with its thrust load capacity of 4,630,000 lb., its diameter of almost 3'-0" and its 3 roll assemblies with 6 precision thrust plates matched to equalize load and deflections for each stage. But we're equally proud of the little 2 incher in Design Engineer Grigson's hand. Despite the great difference in size, each has been carefully worked out *"to do the job required in the one best way."*

Whether you want a bearing for an oil rig, an extruder, a pulp mill jordan, a crane hook, a heavy duty lathe and countless other uses, Rollway has one that will do the job "in the one best way."

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Our engineers will gladly consult with you regarding the standard or special-purpose types you need.

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Core Is Installed in Shippingport Atomic Electric Generating Station

▲ ENGINEERS and technicians of Duquesne Light Co. and Bettis atomic power division of Westinghouse Electric Corp. on October 5 lowered the nuclear core, or charge of fuel, into position in the nation's first fullscale atomic electric generating station near Pittsburgh.

The delicate operation was heralded as an important and historic step toward completion of the world's first full-scale atomic power station devoted exclusively to serve civilian needs.

It is within this core that the "hot" nuclear reaction, or fission process, will take place. The nuclear furnace will heat high-pressure water which then will turn a second supply of water into steam. The steam in turn, as in a conventional coal-fired electric generating station, will produce electricity to serve Pittsburgh area industry and homes.

The Shippingport plant is a joint project of the Atomic Energy Commission and the Duquesne Light Co. of Pittsburgh. Westinghouse, under contract to the AEC designed and developed the nuclear reactor. Duquesne Light is building the electric generating portion of the plant and will operate the entire station.

The 58-ton core, the "heart" of the reactor system was lowered into its giant container, slowly because of the tight 0.06-in. clearance between walls of the stainless steel container, or pressure vessel. The interior of the vessel, which stands 33 ft high and has an inside diameter of 9 ft, is lined with ¼-in. thick stainless steel that provides maximum corrosion resistance.

The operating weight of the reactor, including the uranium fuel, is more than 250 tons. It is the heaviest piece of atomic equipment in the world.

The core for the pressurized water type reactor is only 6 ft long and is more than 6 ft in diam. It includes 14 tons of natural uranium surrounding some 165 lb of highly enriched uranium "seed." There are 32 "seed" fuel elements and 113 natural uranium elements in the core.

The Shippingport plant is part of the AEC's program to develop industrial nuclear power. It contains a 100,000-kilowatt turbine generator which was built at the East Pittsburgh and Lester, Pa., plants of Westinghouse.

Within the nuclear reactor will be 32 control rods for controlling the atom splitting or heat producing process. Inserting the rods into the reactor slows the fission process; withdrawing them speeds it up. The rods are made of hafnium metal which was selected because by readily absorbing neutrons it affords careful regulation of the fission process.

Extremely pure water, which serves both as moderator and coolant, will flow at the rate of 18,000 gpm through each of four main coolant loops in the plant to produce the 60,000-kw minimum power. The water will be at 2000-psi pressure with an average temperature of about 525 F.

The entire nuclear portion of the power plant is housed in four steel containers which, in turn, are in concrete compartments partially below the ground level. The exterior of the facility does not look too different from a conventional power plant except for the absence of large stacks and fuel storage and handling facilities. Over-all control of the plant will be from a single control center.

Considerable work remains before the control rods can be raised so that the plant begins to produce atomic heat sufficient for operation. Because the plant is a "first," this work must proceed slowly as the engineers work out problems for which there are no precedents.

Figure 1 — This 58-ton, multi-million dollar nuclear core, or fuel charge slowly is lowered into position with its precious fuel consisting of 14 tons of natural uranium and 165 lb of enriched uranium.

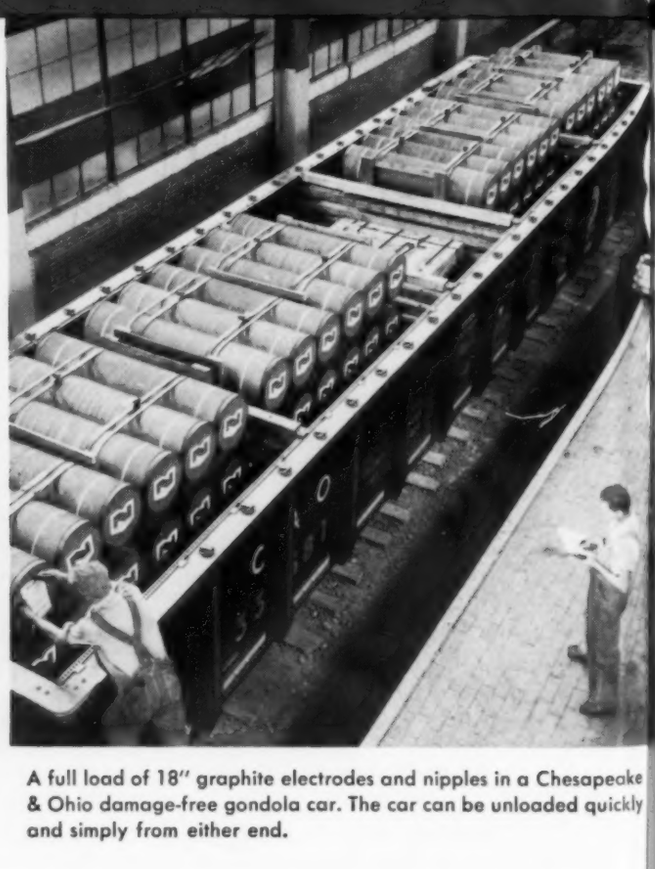
one more reason to specify

NATIONAL ELECTRODES
TRADE-MARK

IMPORTANT NEW SAVINGS for ELECTRIC FURNACE OPERATORS

PIONEERED BY NATIONAL CARBON COMPANY

Seven ¼" steel rails run length of car sides. Cross-members of 9-gauge steel, wood-faced to prevent gouging, fit into 1" center rail holes to give each compartment a restraining force of 42,000 lbs.



A full load of 18" graphite electrodes and nipples in a Chesapeake & Ohio damage-free gondola car. The car can be unloaded quickly and simply from either end.

Twenty seven 35" x 110" electrodes loaded in a new Union Pacific damage-free gondola car.
Previous gondola car design permitted a maximum load of only fifteen electrodes of this size.

Now, in addition to assuring safe electrode shipments, you can simplify unloading, avoid demurrage and greatly reduce dunnage disposal problems. The reason: new damage-free gondola cars developed jointly by National Carbon Company and the Evans Products Company.

Thanks to an ingenious system of adjustable bracing, these "DF"† gondola cars require minimum dunnage yet carry substantially greater loads than ordinary gondola cars. Unloading from either end of the car is quick and simple. Since cars are not tied up long and average shipments are larger, furnace operators save penalty fees and cut handling costs.

Helping customers cut costs is only one of National Carbon's customer services. Be sure to specify NATIONAL CARBON COMPANY ELECTRODES, product of the nation's foremost electrode producer.

NATIONAL CARBON gives furnace operators . . .

* Highest uniform electrode quality
* National service organization
* Technical electrode program for operators
* Scientific packaging to assure damage-free delivery . . . to keep electrodes clean . . . to eliminate in-plant handling damage

†"DF" is a trade-mark of Evans Products Company.

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Load Cells Offer New Solutions to Industrial Weighing Problems

By DAVID VANDEVENTER
Engineering Dept.,
Leeds and Northrup Co.

▲ ELECTRIC-TYPE load cells, properly used with electronic instruments, have found many important new applications for weight measurement. They offer unique advantages for measurements which involve such difficult factors as:

1. Impact and vibration.
2. Adverse ambient conditions.
3. High speed measurements.
4. Awkward mechanical structures.
5. Portable equipment.

Frequently, combinations of these factors in a given installation make weight measurement with load cells spectacularly successful.

In addition to the special advantages, load cell systems have several inherent features. They can easily provide remote indication or continuous recording of weight, with the addition of automatic control, if desired. Further, systems can be set to indicate a differential weight above or below any given value. For example, 100 lb over a base load of 10,000 lb.

Sensitivity and accuracy are characteristics which vary with the specific load cell system. However, the potentials of this method are dramatically indicated by the case of a 500-lb range cell which is capable of detecting 1-ounce washers —a sensitivity better than 1 part in 300,000.

This article reviews the basic characteristics of load cell measurements and gives examples of typical industrial applications. These examples should serve to help users visualize other possible applications, or means of improving present measurements.

The load cell may be defined as a weight measuring unit with an output signal capable of transmission to a remote point. In its most commonly used forms (Figure 1) the cell employs an electric signal which a suitable instrument translates into an indication or continuous record of weight.

Load cells have one basic characteristic which must be clearly understood: their output signal depends upon the elastic properties of a structural element which supports the weight being measured. This relation has been refined, compensated, and improved by a number of ingenious methods. However, measurement of weight by a load cell is fundamentally a deflection measurement.

The deflection factor is important, because, in order to realize the maximum advantages of load cell measurement, some problems require that the gross load must be supported by the cell or a group of cells, while others may dictate that only a fraction of the load be

Figure 1 — Load cells are typical of those used for weight measurement.

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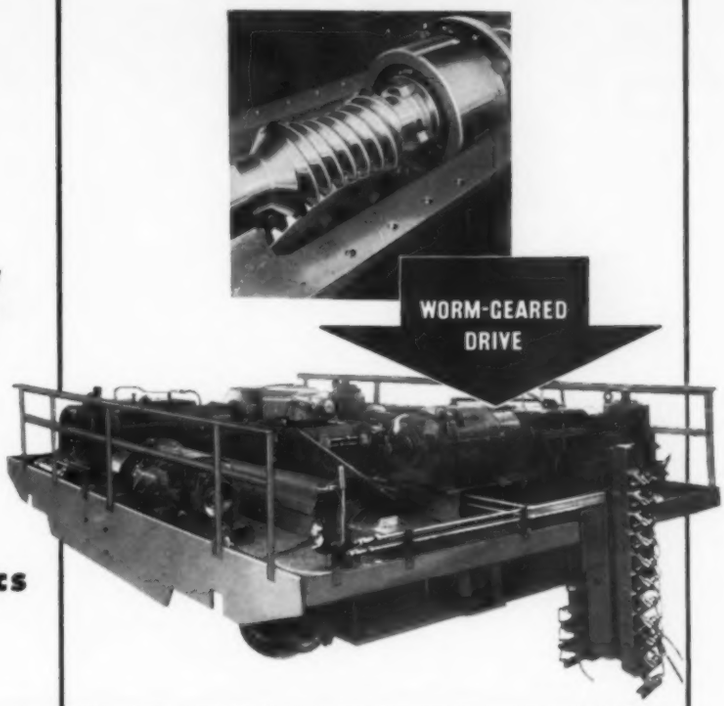
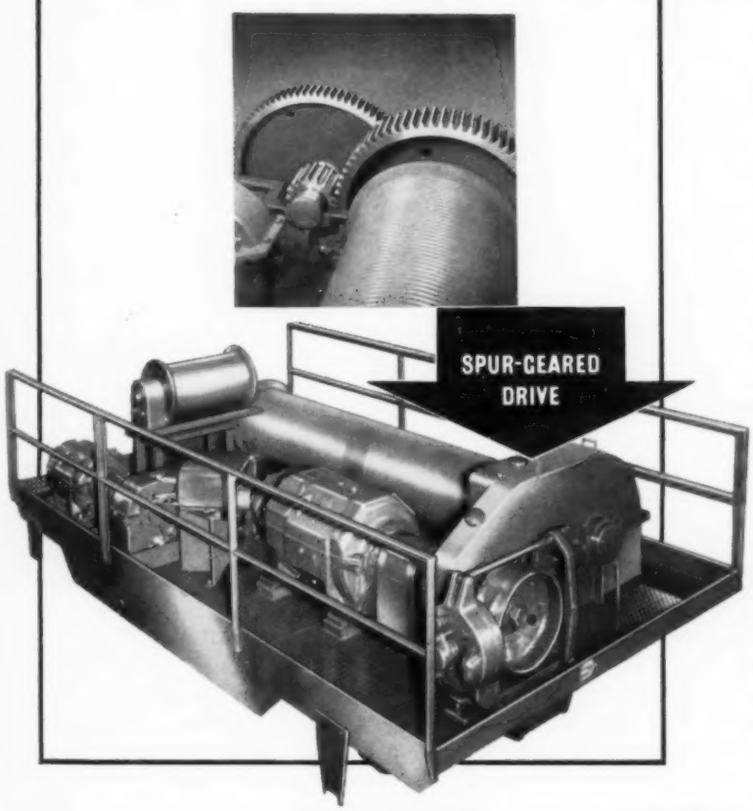
YOU LIKE BEST

SHAW-BOX

Builds both to A.I.S.E. Specs





You want trolleys of the type your experience has proved are best for your particular requirements. The two types of trolleys and their gearing shown here illustrate how A.I.S.E. specifications are interpreted by Shaw-Box in satisfying the needs of two different mill applications.

Whether you prefer worm or spur gearing on your trolleys, turn to Shaw-Box and be sure of the finest in precision manufacture. Our long experience in designing, engineering and building load handling equipment exclusively assure you of continuously dependable performance, regardless of service conditions.

Over the years, we have produced many 5 to 200-ton cranes of various types to A.I.S.E. specifications and to the specifications of individual mills. Their work records prove the economic value of mechanical and operational features conceived and introduced by Shaw-Box. So if your plans include a crane to handle plate or slabs, a soaking pit carriage or a giant ladle crane, we invite your inquiry.

"Shaw-Box"® CRANES

57K-1

MANNING MAXWELL & MOORE INC. M&M TRADE MARK

MANNING, MAXWELL & MOORE, INC.

SHAW-BOX CRANE & HOIST DIVISION

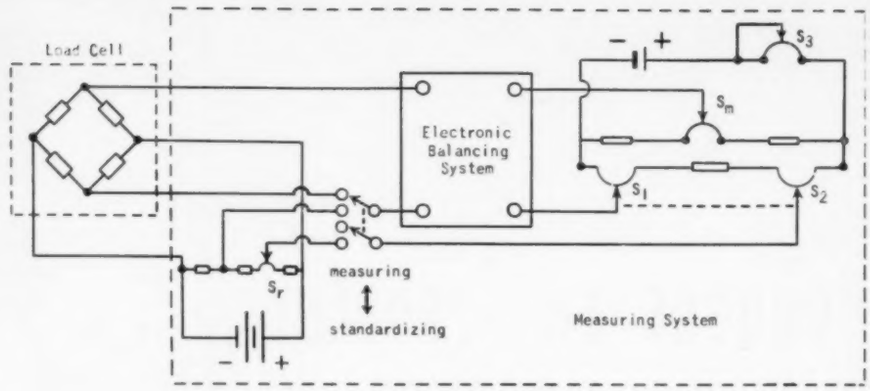
388 West Broadway • Muskegon, Michigan

Builders of "SHAW-BOX" and 'LOAD LIFTER' Cranes, 'BUDGIT' and 'LOAD LIFTER' Hoists and other lifting specialties. Other Divisions produce 'ASHCROFT' Gauges, 'HANCOCK' Valves, 'CONSOLIDATED' Safety and Relief Valves, 'AMERICAN' and 'AMERICAN-MICROSEN' Industrial Instruments, and Aircraft Products.

In Canada: ***Manning, Maxwell & Moore of Canada, Ltd., Avenue Road, Galt, Ontario.***

applied to the cell. Hence, load cells must be used with various mechanical devices to balance tare load, provide over-load protection, improve accuracy, and otherwise insure dependable performance. The application engineer must thoroughly understand that the device is equivalent to a calibrated spring, or a "fish scale"—rugged and refined as it may be.

The load cell operates on the principle that the resistance of wire increases as the wire is stretched under a load. Thus, by a suitable arrangement of wires in a unit subjected to a load, the weight can be related to this resistance change. The resistances are arranged in a bridge network so that the output voltage signal is proportional only to resistance change produced by load. Temperature and other effects on the resistance values are cancelled. The output voltage is then measured on a precision potentiometer-type instrument. Figure 2 shows a typical circuit diagram.



S_r: Range Span Adjustment

S_3: Battery Rheostat.

S_m: Measuring Slidewire

S_1, S_2: Provide (1) zero adjustment (2) Constant standardizing resistance.

Figure 2 — Schematic circuit diagram shows load-cell bridge connected to bridge voltage supply and potentiometer circuit of electronic instrument. Resistance changes in the load-cell result in bridge unbalance and load measurement.

APPLICATION FACTORS

With a basic understanding of load cell principles, consider now the special advantages offered by load cells in solving difficult weight measuring problems.

Vibration and impact—the compact size and the rigid construction of the cell allows tight coupling between the load and the foundation structure. Therefore, under vibration, the force applied to the load cell varies, but no relative motion between parts occurs and damage to bearing points is eliminated. The signal generated by the cell follows the vibrating load, but simple electrical filters suppress this effect without difficulty. Weighing hoppers on lorry cars, and metering bins with vibrator-type discharge feeders are two examples of problems which have been successfully solved.

Impact loading is a somewhat more difficult problem, because as noted previously, load cells depend on the elastic properties of some structural element. If the elastic limit is exceeded by an overload—accidental or otherwise—an irreversible zero-shift results. Oddly, this same elastic deflection is the basis of one of the simplest methods for protection of load cells. In several rocket test stands, a rigid overload stop bears the load after the cell has been strained to its rated capacity.

Usually, for industrial service, the precise positioning required by such a stop is impracticable. For such problems, the total deflection of the system may be increased by inserting a softer spring element between the load and the load cell, and an overload stop spaced at a more convenient distance. An ingenious installation of this type is shown in Figure 3.

Adverse ambient conditions—The measurement of weight where corrosive materials and water are present, as in chemical and water treatment plants, presents a difficult problem, to which there is no perfect answer. The simpler the structure, however, the easier it is to protect and maintain the equipment. Hence the load cell comes into its own, because a tank or platform, resting on three or four rigid, sealed units offers just about the ultimate in simplicity.

The weighing units of such a system may be given a coat of corrosion-resistant paint for additional protection without impairing the accuracy of measurement. In some installations the cells are regularly hosed down with water to avoid accumulation of corrosive material or to maintain sanitary conditions.

Load cells are quite satisfactory where fine abrasive dust is present. Sand particles in foundries and fly-ash near large coal-fired boilers take a severe toll on any moving system. Several successful applications of load cells have been made in foundries, sand mills and similar dusty areas. See Figure 4. Notice that this particular installation includes a severe shock load hazard from the skip bucket. Seven similar units have been in continuous service for about seven years.

High speed measurement—Higher and higher speed of measurement is a fundamental need in our advancing technology and in the rapid extension of automation. Load cells have helped to lessen the speed limits in measurement of weight. The reason may again be traced to the fact that load cells function by virtue of an elastic deflection. In most units, the total motion is small.

For example, in a typical Baldwin-Lima-Hamilton SR4 type cell, the deflection at full capacity is approximately 0.005 or 0.006 in. Inherently, such a device has a high natural frequency; that is, it is capable of following, accurately, very rapid changes in applied force. Some of the most spectacular applications of load cells are in testing rocket engines, jet aircraft supersonic wind tunnel models and the like.

Successful industrial weighing applications of load cells by Streeter-

(*Please turn to page 177*)

this **NEW**

ELLIOTT CROCKER-WHEELER

620 MILL MOTOR

reaffirms Elliott's 50-year leadership in the development and design of mill-type motors

The new 620 mill motor in protected, forced-ventilated design. Note motor-driven blower and filter.

IN 1904 Elliott's Crocker-Wheeler Division introduced the *first* "mill-type" motor . . . insulated with asbestos and mica . . . "bull strong." In the succeeding 50 years, Elliott repeatedly introduced bigger and tougher mill motors, keeping pace with the steel industry's needs.

TODAY—The new Elliott "620 Frame" mill motor packs even more horsepower . . . with rolled steel frame, horizontally split for easy access . . . silicone-insulated windings (entirely Class H) . . . furnished totally enclosed, protected self-ventilated, protected or enclosed forced-ventilated.

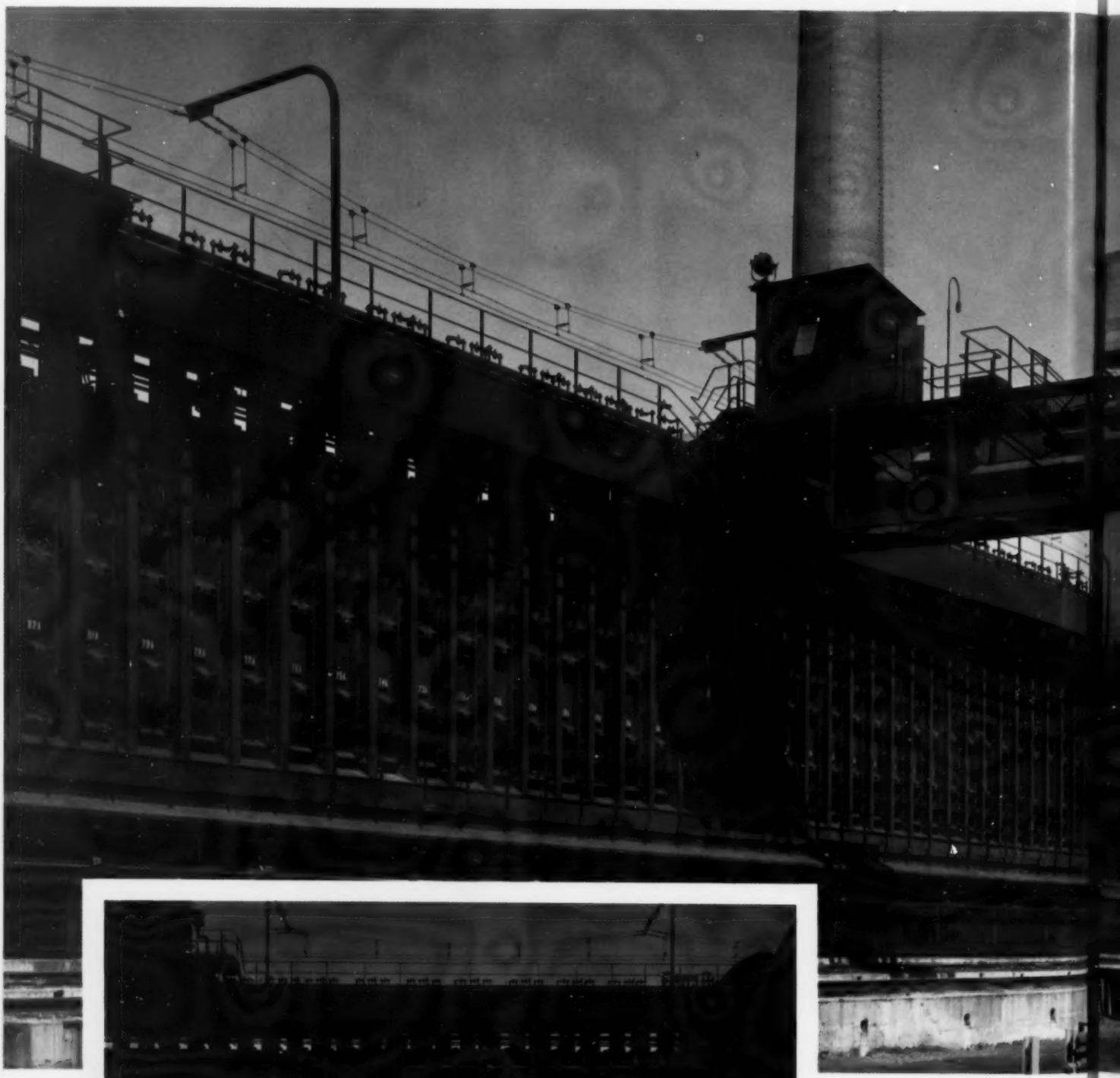
ELLIOTT Company

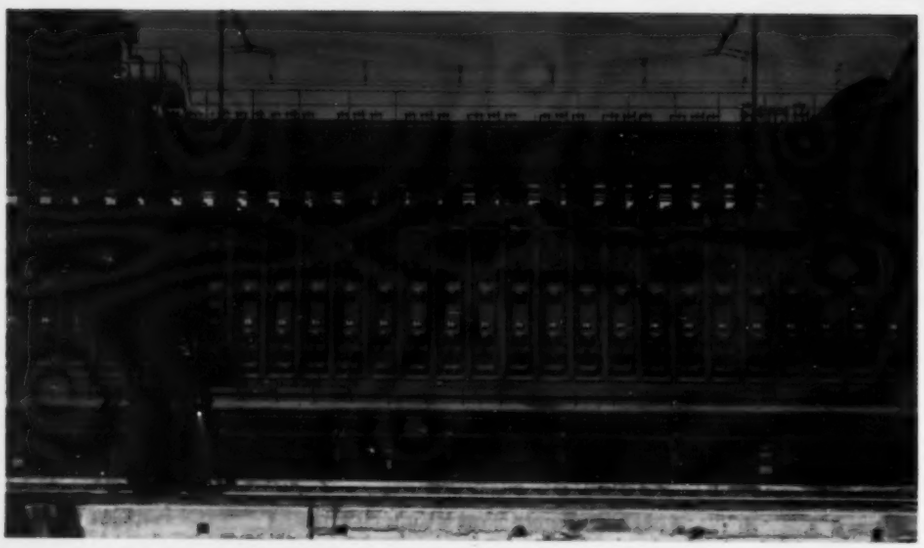
CROCKER-WHEELER PLANT

JEANNETTE, PENNSYLVANIA

W7-7

Repeat order for Koppers
Youngstown Sheet & Tube





Battery No. 4—is shown in these photos the Coke Plant at Youngstown Sheet Tube's Indiana Harbor Works.

rs Coke Ovens at the
be Company

Dependable service from existing battery leads to purchase of 75 more Koppers Ovens

BATTERY NO. 3, consisting of 75 Koppers-Becker Underjet Coke Ovens, was put into operation in 1952 at the Indiana Harbor Works. In 1955, Youngstown required additional coke-making facilities, and chose Koppers to design and construct a new battery, which is a duplicate of Battery No. 3.

2,000 net tons per day

The new Koppers battery went into operation late in 1956. Its 75 ovens carbonize approximately 2,000 net tons of coal per day. Oven walls feature Koppers patented and highly regarded Hammerhead construction. Recirculation of waste gas insures uniform heating, cuts down fuel consumption, and eliminates any need for decarbonizing equipment—an important saving.

Coke oven or blast furnace gas

Now underfired with coke oven gas, the new battery can later be fired with blast furnace gas if desired. This construction, which permits both types of gas to be used, was first developed and introduced by Koppers.

Koppers accustomed to repeat business

Koppers has built the majority of coke ovens in the United States. Much of this business, like the new battery for Youngstown Sheet & Tube, is *repeat* business—the kind you get only if your product has given satisfactory service.

We think this is a good reason for *you* to specify Koppers—not only for coke ovens, but for all other steel-plant installations. Koppers brings you 50 years of service and experience. The Coke Plant, Freyn, and Chemical Departments have done work on nearly all types of steel-making equipment. Write or call for information. Koppers Company, Inc., Engineering and Construction Division, Pittsburgh 19, Pennsylvania.

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own Sheet
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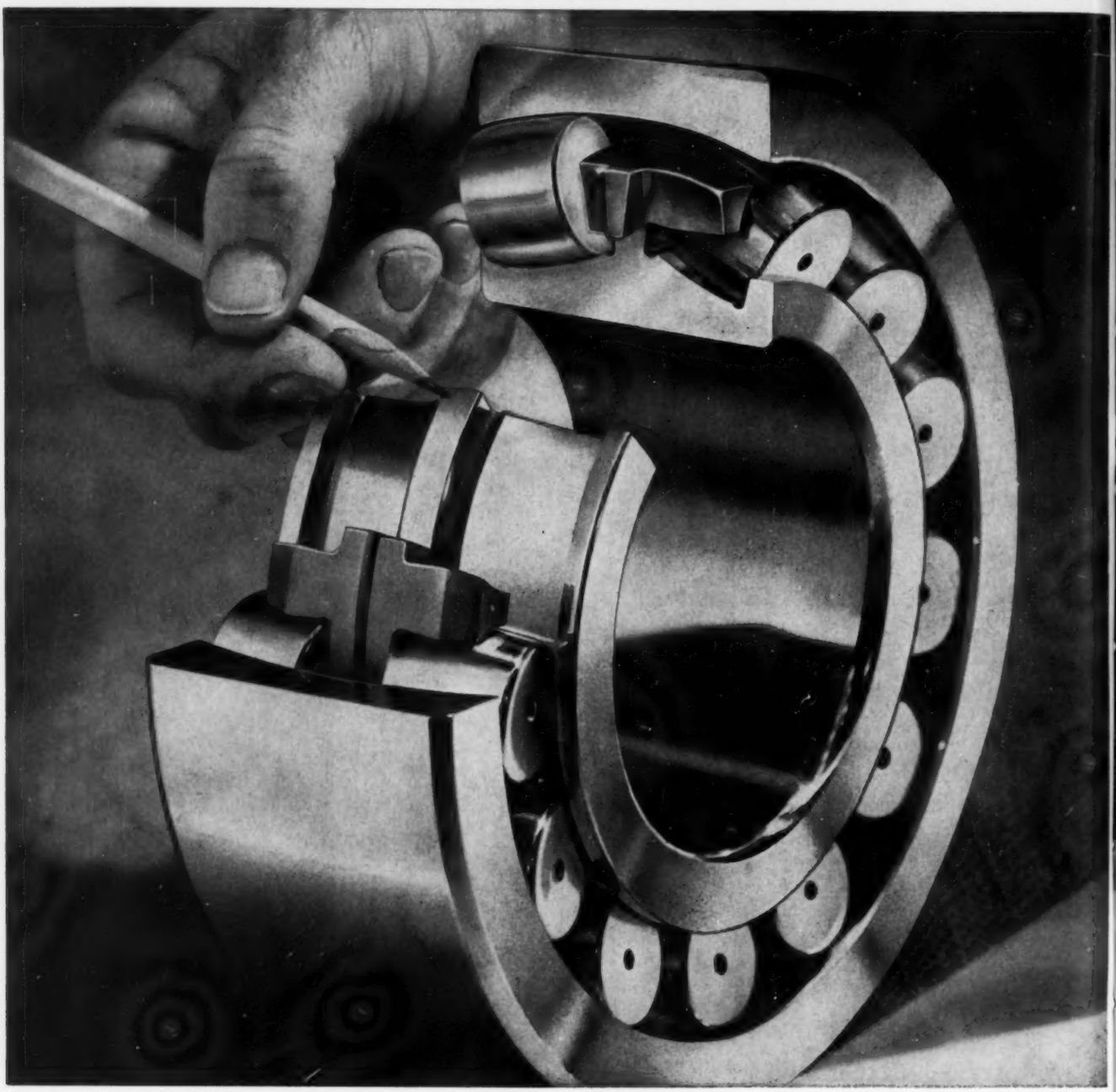
KOPPERS ®

KOPPERS

ENGINEERING AND CONSTRUCTION

TORRINGTON *SPHERICAL ROLLER* BEARINGS



"This flange guides the rollers to peak performance!"

The center flange on the inner raceway of the TORRINGTON Spherical Roller Bearing positions the rollers to handle thrust loads. This accurate positioning also assures radial stability of the rollers under heavy loads—even at continuous high speeds and under conditions of misalignment.

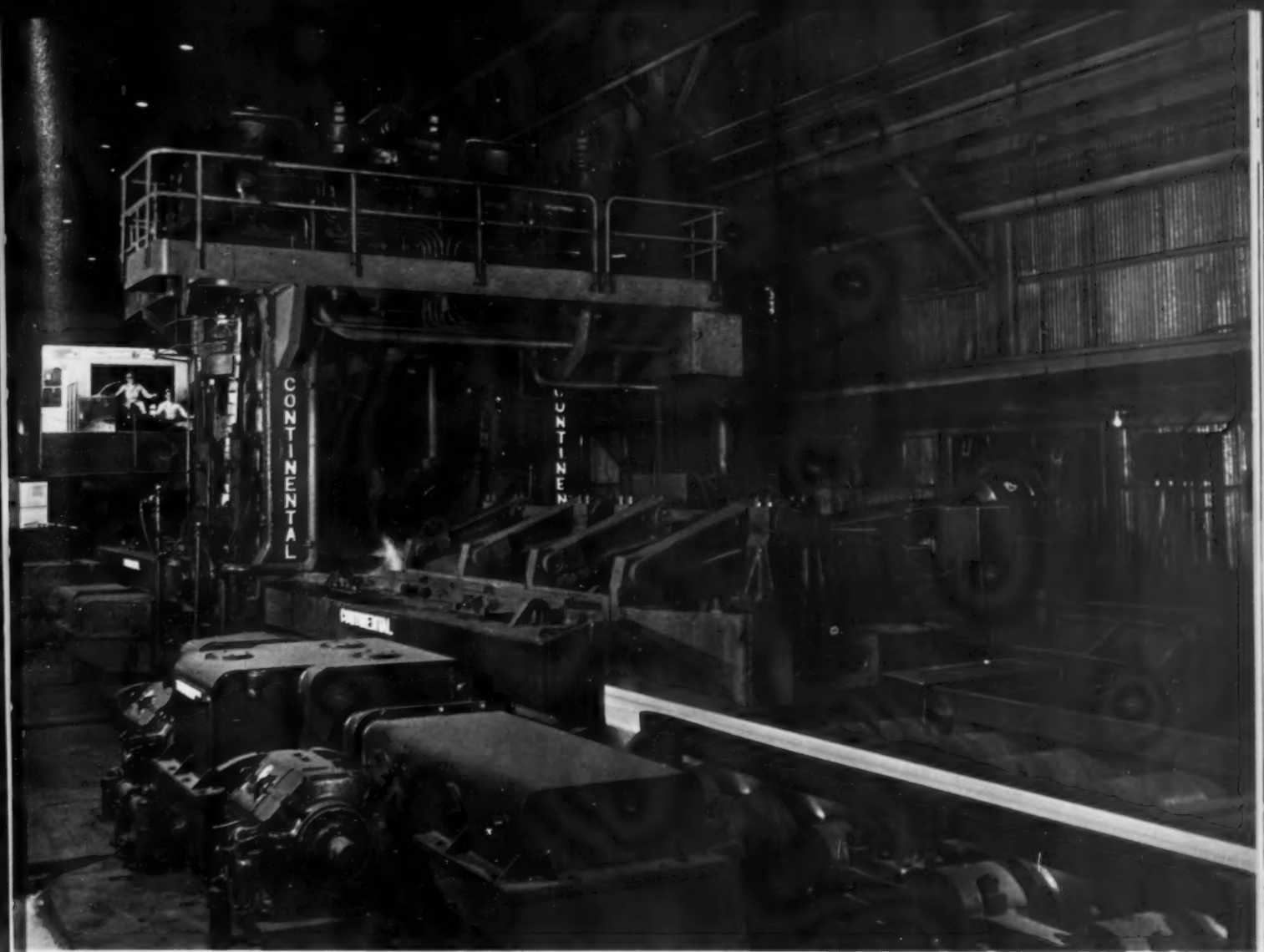
This superior design feature is only one of many advantages you get when you specify TORRINGTON. For example, you get the service of TORRINGTON'S experienced engineers, who will help you with design and maintenance problems—or design custom bearings for special applications.

For long, low-maintenance service in heavy-duty applications, order TORRINGTON Spherical Roller Bearings. They're available from stock with either straight or tapered bore, for shaft or adapter mounting.

THE TORRINGTON COMPANY
South Bend 21, Ind. • Torrington, Conn.
District offices and distributors in principal cities of United States and Canada

TORRINGTON BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller
Needle • Ball • Needle Rollers



40 x 96 inch, 2-high blooming mill at the Fairless Works of the United States Steel Corporation, designed and built by Blaw-Knox.

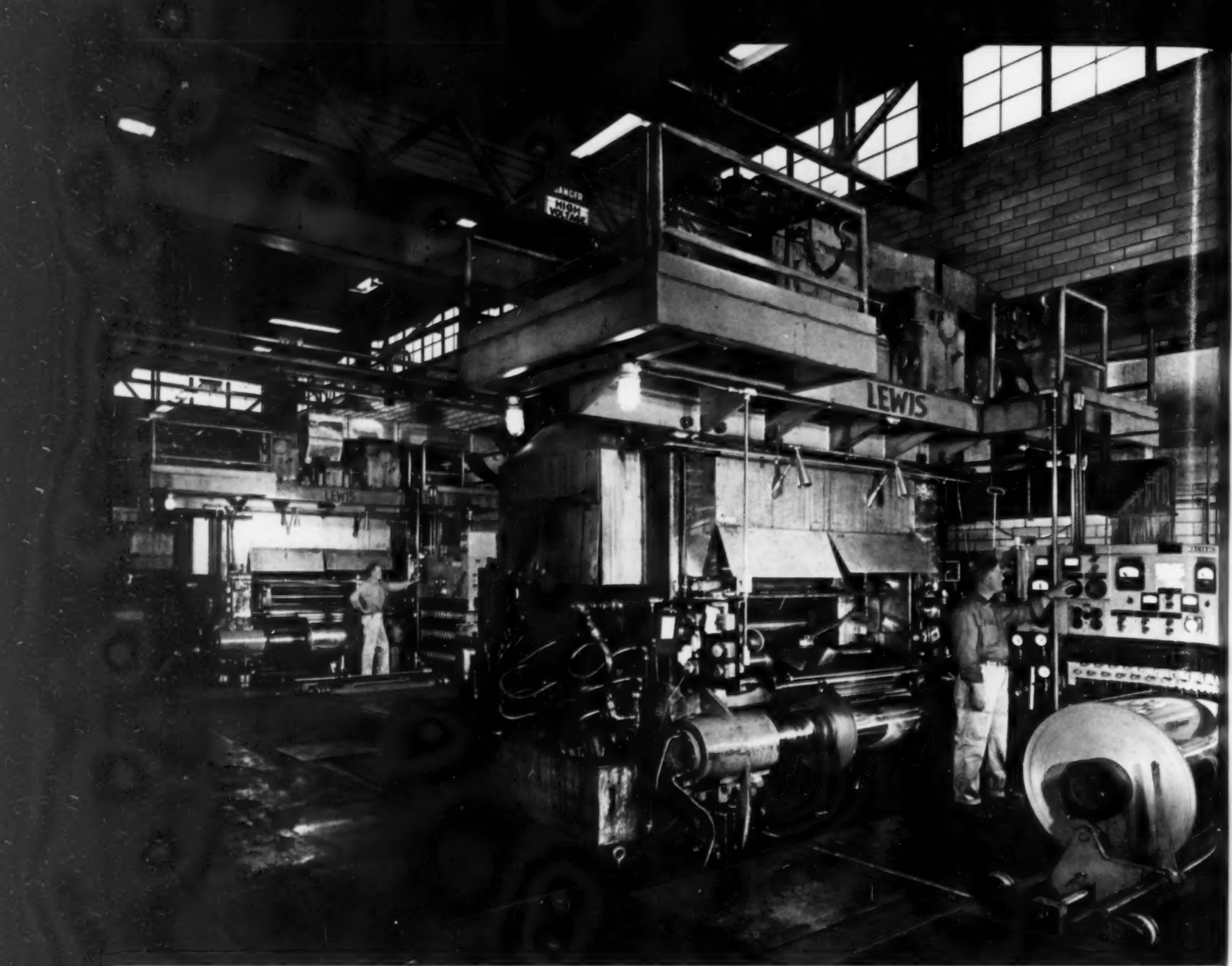
BLAW-KNOX
BLOOMING MILLS

Blaw-Knox designs and builds slabbing-blooming mills in a complete range of sizes in high-lift and universal types. Other Blaw-Knox designed equipment for the metals industry includes complete rolling mill installations and auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron and steel rolls, Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or composite design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

BLAW-KNOX

BLAW-KNOX COMPANY

Foundry and Mill Machinery Division
Blaw-Knox Building • 300 Sixth Avenue
Pittsburgh 22, Pennsylvania



10 and 31 x 62-inch 4 high mill at
Cochran Foil Company, Louisville, Kentucky.

BLAW-KNOX
ALUMINUM FOIL MILLS

Blaw-Knox designs and builds a full range of Aluminum foil mills complete with auxiliary equipment to meet individual requirements. Other Blaw-Knox equipment for metals industry includes complete rolling mill installations including all auxiliary equipment for ferrous and non-ferrous metals, iron, alloy iron and steel rolls, Medart cold finishing equipment, carbon and alloy steel castings, fabricated steel plate or cast-weld design weldments, steel plant equipment, and heat and corrosion resisting alloy castings.

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Foundry and Mill Machinery Division
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Pittsburgh 22, Pennsylvania

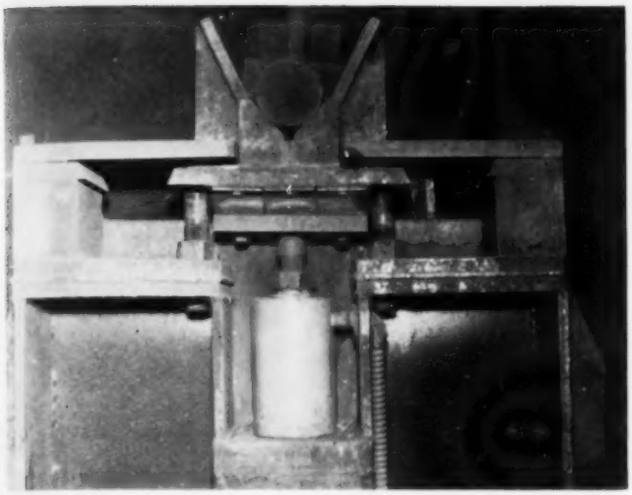


Figure 3 — Load cell supports foundry furnace charging bucket which is loaded by an overhead crane. Overload protection is provided by a soft-spring element between the cell and the bucket support.

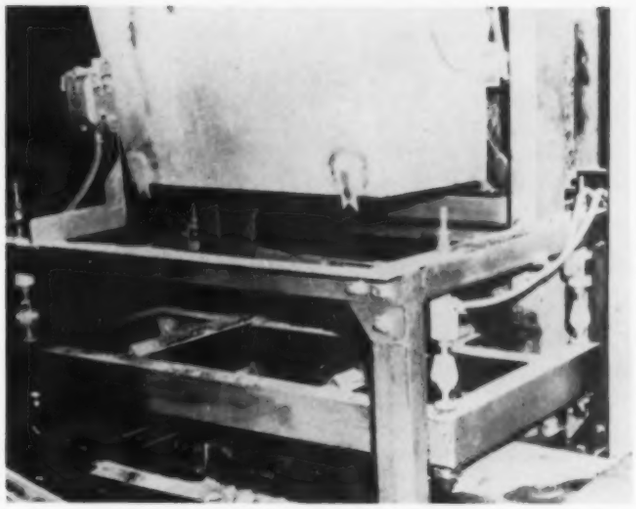


Figure 4 — Four load cells support foundry sand weighing cradle, overcoming problem of severe shock from skip bucket.

(*Continued from page 170*)

Amet, IBM, and others include problems of motor truck logging on turnpikes, railroad switch yard weighing, and the like. In several industrial problems involving repetitive operations on product weight, on which Leeds & Northrup has worked, the high speed or response possible with load cells was an important factor in achieving a satisfactory solution. In industrial laboratories such as the helicopter rotor test stand (Figure 5), load cells and load cell instrumentation played a vital role in accurate measurements.

Awkward Structures—Properly supporting certain types of structures and at the same time realizing a useful weight measurement is an awkward problem which has considerably promoted the use of load cells. A dramatic example is the railroad track scale installed several years ago by Baldwin-Lima-Hamilton and since repeated in several forms by other companies. Figure 6 shows the simplicity of foundation and structural support achieved.

Large tanks utilize load cells in a very simple form of support with an output signal proportional to weight (Figures 7 and 8). Some of the most awkward mounting problems have come because of space limitations. Lack of space available in equipment for accurately measuring and controlling wire tension during winding dictated the use of a load cell and a high speed electronic instrument.

Portability—Portable equipment demands characteristics which encourage the use of load cells, such as small size, light weight and rigid construction. Cox & Stevens Aircraft Co. has made portable aircraft weighing equipment using load cells for several years. Baldwin-Lima-Hamilton and Harnischfeger Corp. have successfully mounted electric load cells in crane-scale hood assemblies. Electric transmission of output signals is particularly convenient for portable equipment. The principal problem is protecting the cells against accidental overloads, particularly those from shock or impact.

INDICATING, RECORDING, AND CONTROL

High-speed electronic instruments, developed and refined to a high

Figure 5 — Load cells measure helicopter rotor-lift. Electronic recorders are at right and left.

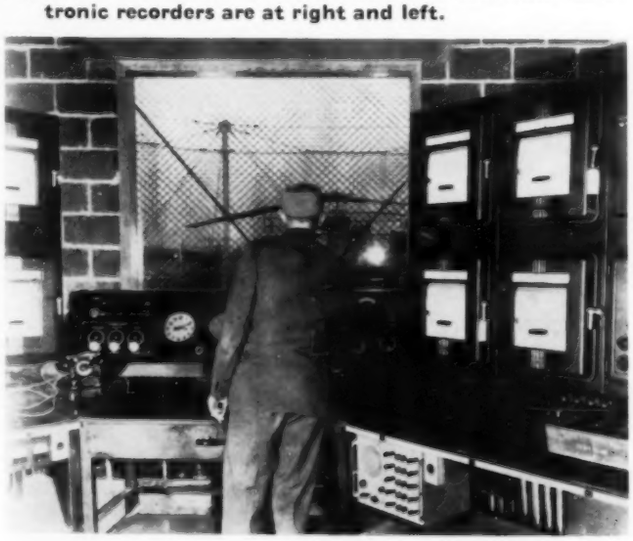
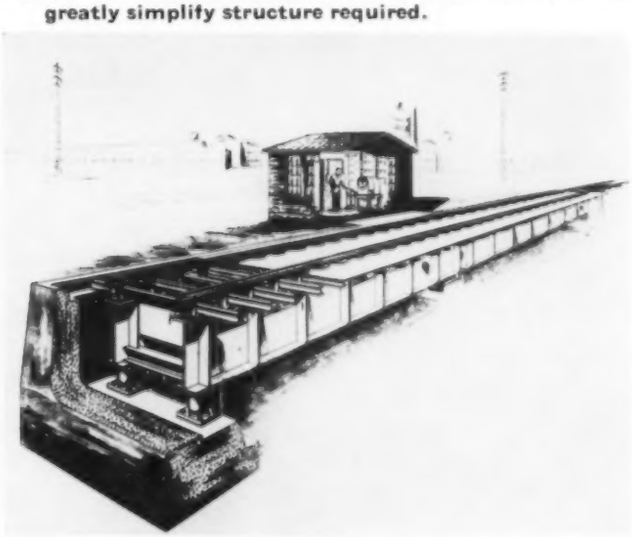


Figure 6 — Railroad track scale employs load cells to greatly simplify structure required.



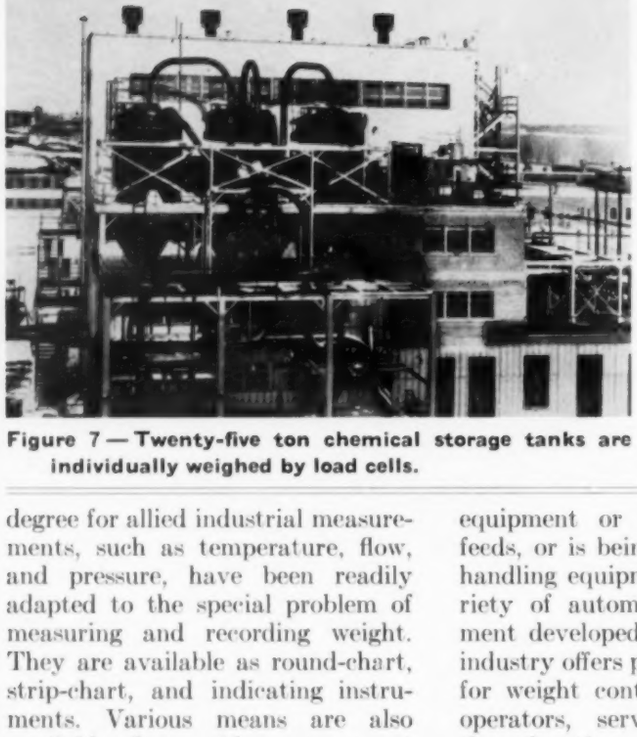


Figure 7 — Twenty-five ton chemical storage tanks are individually weighed by load cells.

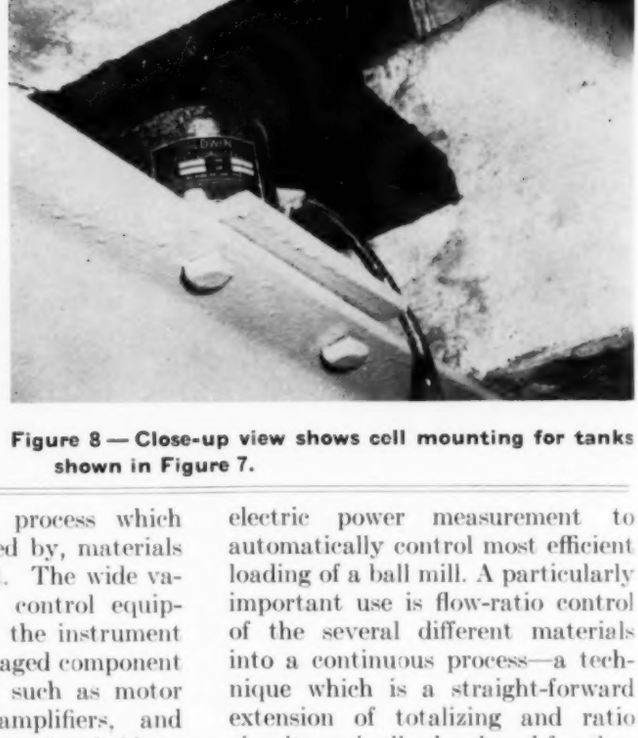


Figure 8 — Close-up view shows cell mounting for tanks shown in Figure 7.

degree for allied industrial measurements, such as temperature, flow, and pressure, have been readily adapted to the special problem of measuring and recording weight. They are available as round-chart, strip-chart, and indicating instruments. Various means are also available for making permanent digital records either as printed or punched cards, for later automatic processing by accounting machines.

One of the most important techniques possible with load cell instrumentation is multiple-point measurement, wherein several load-cell signals are measured sequentially on a single recorder or indicator. On an Atomic Energy Commission installation for which L&N supplied equipment, weight of material in each of ten separate storage locations is recorded on a single instrument.

A logical extension of weight measurement is control of loading equipment or the process which feeds, or is being fed by, materials handling equipment. The wide variety of automatic control equipment developed by the instrument industry offers packaged component for weight control, such as motor operators, servo amplifiers, and three-function control bridges. Several examples suggest the versatility of the equipment.

Batch addition of several ingredients in preset amounts can be automatically controlled on a weight basis. In one foundry, for example, three kinds of sand are fed in prescribed weights into the cradle as shown in Figure 9. Load cells, arranged as on the cradle shown in Figure 4, connect to the control panel which automatically switches sand hoppers as the preset weights are added.

Another interesting application combines weight measurement and electric power measurement to automatically control most efficient loading of a ball mill. A particularly important use is flow-ratio control of the several different materials into a continuous process—a technique which is a straight-forward extension of totalizing and ratio circuits orginally developed for electric power distribution, and regenerative furnace control.

Figure 10 shows the control panel for measuring several charges of molten iron to a multi-flask centrifugal casting machine.

Figure 9 — Load cells provide automatic mixing control of three kinds of foundry sand.

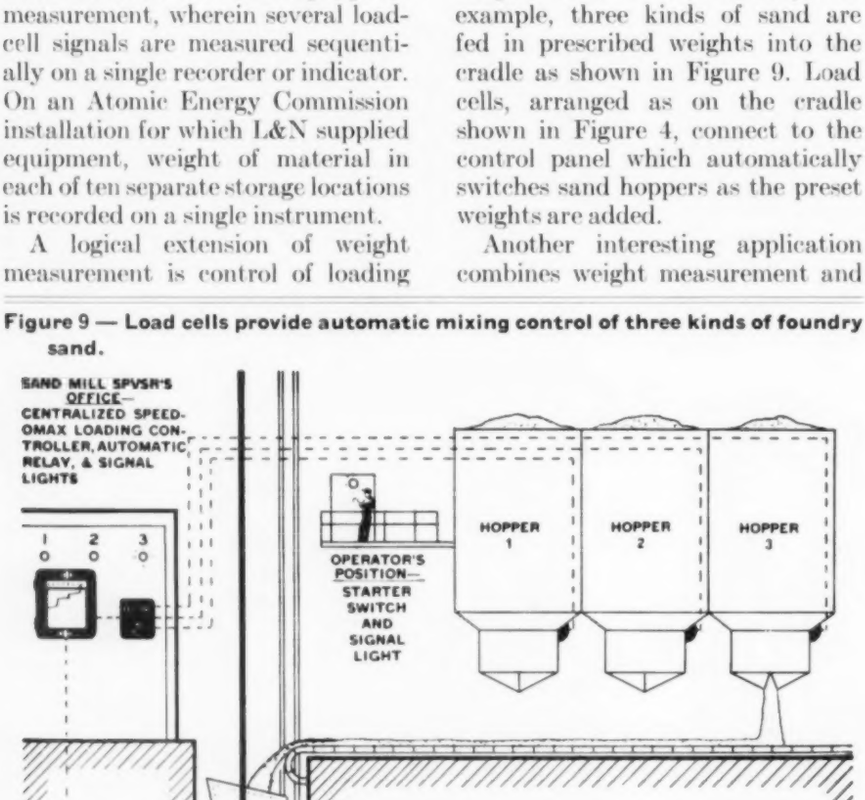
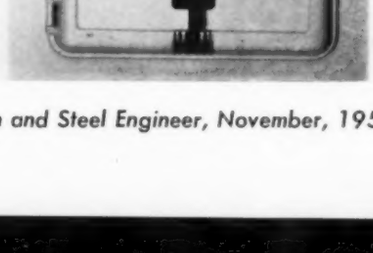


Figure 10 — This panel automatically controls four charges of molten iron to a multiple-flask centrifugal casting machine.



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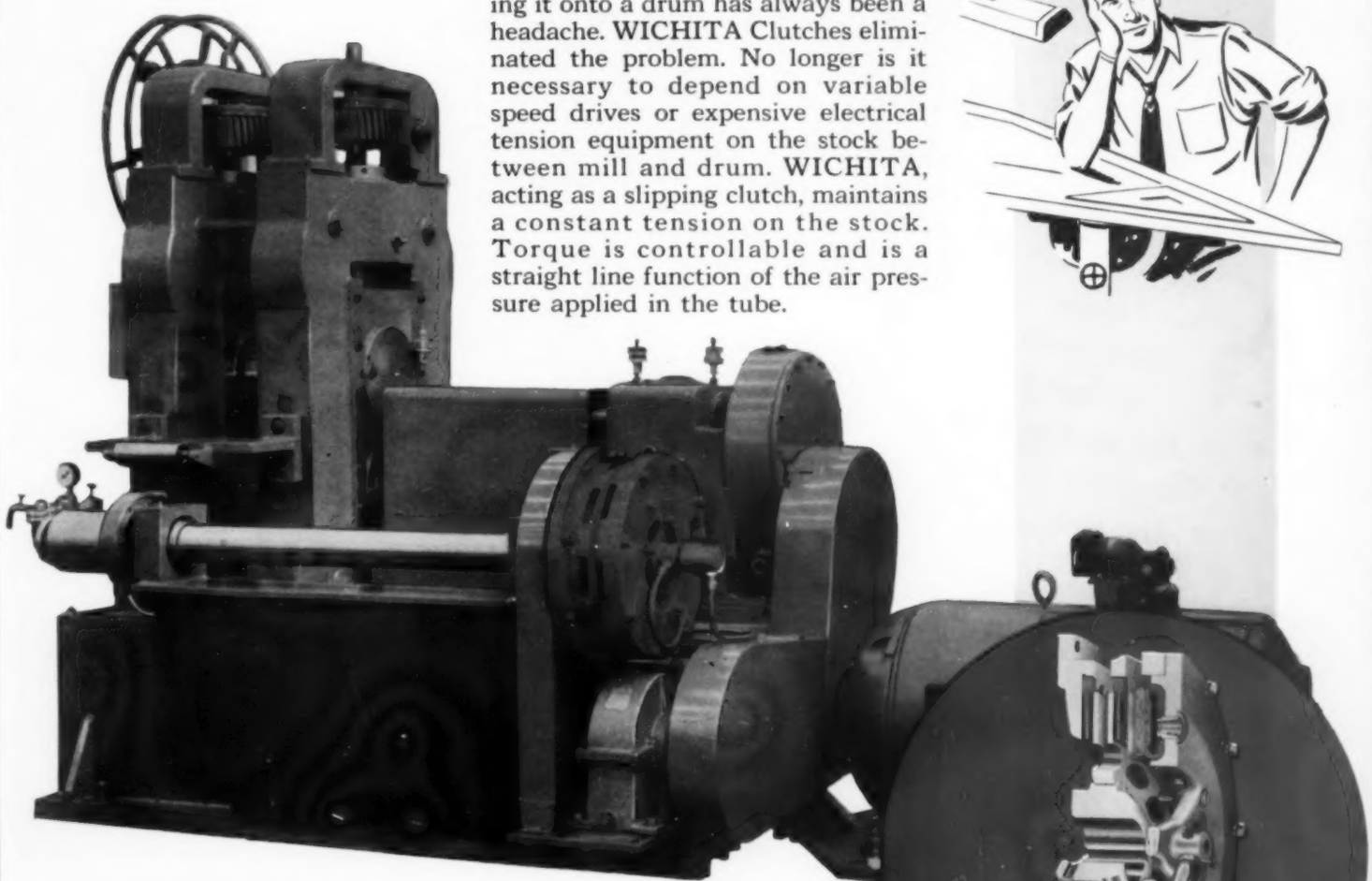
Rolling thin-gage material and coiling it onto a drum has always been a headache. WICHITA Clutches eliminated the problem. No longer is it necessary to depend on variable speed drives or expensive electrical tension equipment on the stock between mill and drum. WICHITA, acting as a slipping clutch, maintains a constant tension on the stock. Torque is controllable and is a straight line function of the air pressure applied in the tube.



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- Controlled Torque — Immediate Response
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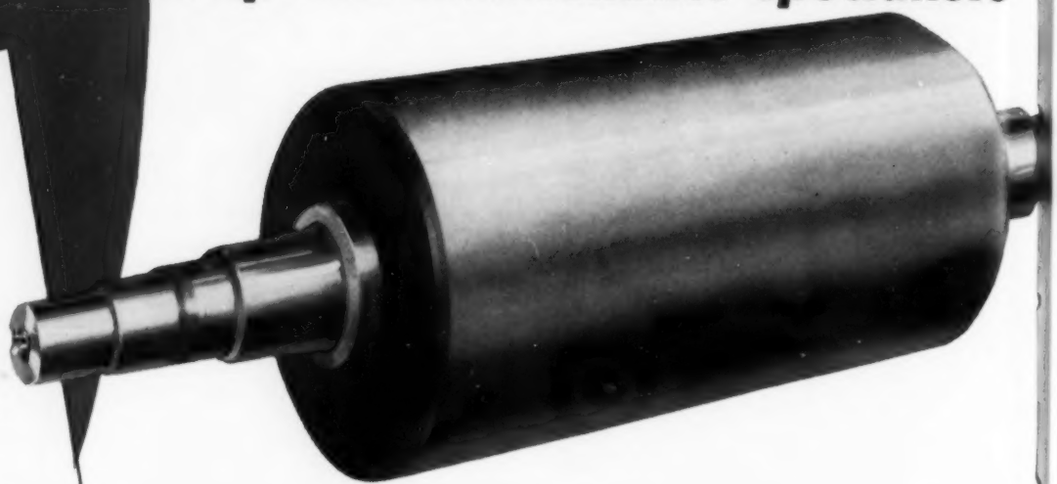
WICHITA Clutch COMPANY, INC.
WICHITA FALLS, TEXAS, U.S.A.

right answers to your Roll problems from "YOUNGSTOWN"

hot and cold strip mill maintenance specialists

Q. How can scratching, galling, pickup, and excess wear be eliminated?

A. Use PARALLOY... the Rolls of uniform hardness all through. Roll more tonnage from new to scrap diameter.



PARALLOY

HOT STRIP COILER ROLLS • COILER PINCH ROLLS
PICKLING LINE PINCH ROLLS • UPCOILER ROLLS
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CARRIER ROLLS • TEMPER MILL TENSION ROLLS

Q. How can heat check, warpage and cracking be overcome?

A. Let Youngstown's proven experience with Ductile Cast Iron help you in the applications at right.

DUCTILE IRON

RUNOUT TABLE ROLLS • HOLDING TABLE ROLLS
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LOOPER TABLES • APRON PLATES

Ductile Cast Iron Rolls are reducing maintenance in hot strip mills . . . especially good under the sprays. We invite your inquiries on rolls or any other ductile iron castings up to 50,000 pounds.

The Youngstown Foundry & Machine Co.

Youngstown, Ohio

Circuit Breakers and Switchgear Feature Design Advances

▲ COMPLETE redesign of its low-voltage power circuit breakers and of the switchgear that makes use of them has been announced by the Switchgear Division of I-T-E Circuit Breaker Co., Philadelphia, Pa.

The result of this advance is improved performance, greatly simplified operation and servicing, and the most complete standardization in construction and assembly to date in the low voltage power circuit breaker field.

The new K-line circuit breakers—600-volt units in 225-, 600-, and 1600-amp frame sizes—are the first to have quick-make manual closure of breaker contacts. I-T-E designations for its new breakers are K-225, K-600, and K-1600.

The new breakers, as much as one-third smaller and 55 per cent lighter than comparable units, also have a new motor-driven stored-energy system for electric breaker closure, easily interchangeable overload trips and vastly increased accessibility to trips and other breaker parts.

Sub-assembly construction, the first in the low voltage power circuit breaker field, slashes time needed for parts replacement and servicing.

The new switchgear, believed to be the smallest in frontal area yet designed, introduces the first closed-door draw-out for low voltage power circuit breakers. Breakers can be moved from operating to test and disconnect positions within their enclosure without opening switchgear cabinet doors.

Reduction in breaker size permits four-high stacking of 600-amp breakers in standard 90-in. high enclosures.

The new K-line breakers and switchgear are designed for commercial building, industrial plant and power station applications—for the switching, control and protection of motors, generators, transformers, feeder circuits and other large electrically-powered equipment.

Major advances in the new K-line circuit breakers, which in addition to use in I-T-E's own switchgear, will be sold to independent switchboard assemblers, include:

Quick-make manual closure—This is a feature that can greatly prolong the life of contacts and even of the breaker, itself, by eliminating damaging arching that results from slow, careless closure by hand.

Motor-driven stored-energy system for electrically-actuated models—This stores energy for closure, thus cutting drain on breaker's secondary circuit from as much as 160 down to 10 amp.

Greatly reduced size and weight—This is a design and installation advantage for switchboard assemblers and a convenience in servicing for equipment users.

Sub-assembly construction—Six sub-assemblies take the place of the 130 separate major parts in previous models. A part replacement formerly requiring an all-day overhaul of the breaker may now be only a one-hour matter of removing and replacing a unit sub-assembly.

Interchangeable overcurrent trips—These are not readily replaceable, through use of sub-assembly construction, to facilitate planned increases in load capacity.

Complete accessibility of trip units—This feature is the result of a more open breaker design. Even in electrically-actuated models where motor and additional accessory controls are built into the breaker, the user still has complete access for setting or removing trips.

Simplification of trip continuous current ratings—Some 9 trip units now cover complete range of continuous current ratings—from 15 to 1600 amp—that formerly required 23 different trip units.

Automatic trip indicator—An escutcheon-mounted, automatic trip indicator shows that the breaker has tripped on overcurrent of undervoltage.

Pull-down handle actuates the stored-energy closing system—The handle's streamlined, semi-flush design prevents accidental breaker tripping.

I-T-E's new switchgear—in addition to advances of the incorporated K-line circuit breakers—also have the following design and construction innovations:

Closed-door draw-out—For the

Figure 1 (left) — Low voltage switchgear shown represents a major advance in this equipment. This switchgear grouping shows new four-high stacking of 600-amp breakers.

Figure 2 (right) — Quick-make, on the manually-charged breaker, is obtained by storing energy in springs by operation of pull-down handle. Top two frozen-action strobe photos show handle positions during spring-charging. In bottom position, spring energy is released to close contacts. Contacts can not be eased together as they can be in conventional breakers.

first time switchgear doors can be kept shut under all conditions of breaker test and operation and during movement to all positions. In addition to added safety, this protects breaker from atmospheric dirt, dust and other foreign matter in many applications.

Smallest size—Size is believed to be less than any comparable low voltage power switchgear. New I-T-E units are narrower than similar equipment.

Unitized construction—This reduces switchgear to three basic components—the breaker, the switchgear enclosure and a cradle assembly on which breaker slides for drawout. Standardization of this assembly and the switchgear enclosure simplifies interchange of various size breakers.

QUICK-MAKE FEATURE

Quick-made closure, formerly available only on electrically-operated breakers, now is a standard feature of all manual breakers in the new K-line.

A spring-action mechanism provides the manual quick-make action. It is powerful enough to close the contacts safely against a full short-circuit fault current.

The first 90 per cent of travel of the new pull-down handle stores energy in the spring. Only in the last 10 per cent of travel is the stored energy released to close the contacts.

Thus, breaker life and operator safety do not depend on the operator's arm and brain. Formerly, a breaker could be destroyed by careless manual closing against a major fault. The new line eliminates this possibility. Because contacts can not be teased together slowly, breaker life is greatly increased even when only closing against rated loads.

Electrically-operated modles in the new K-line have, in addition to the basic manually-charged mechanism, an actuating motor.

This motor-driven stored-energy system requires only 10 amp from a simple power source, such as an ordinary lighting circuit, compared to as much as 160 amp needed by other breakers. Energy for closing is pre-stored, by the K-line breakers, within two seconds. Closing time is five cycles. Other types have to draw high current from a secondary circuit, the instant it is required.

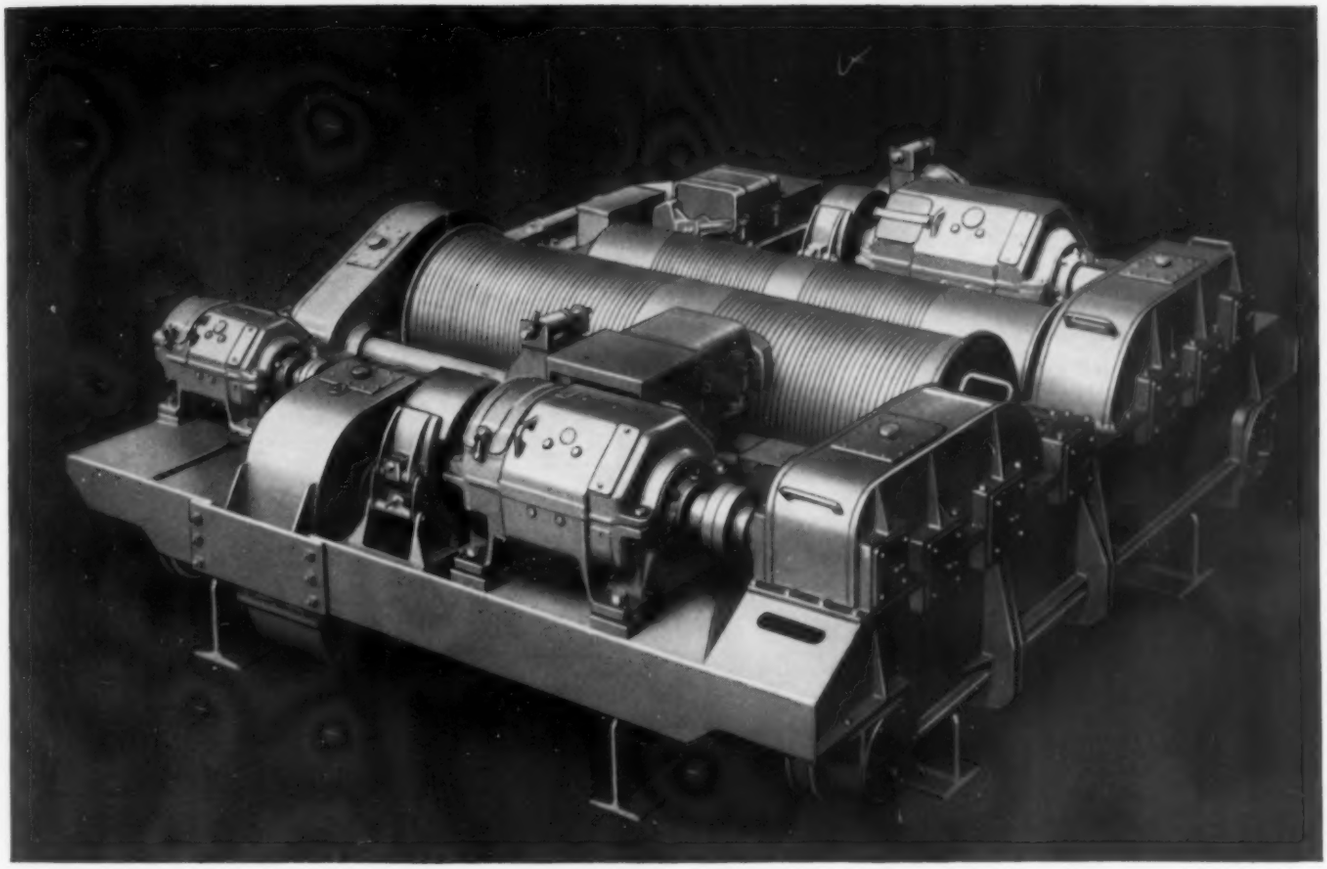
SIZE REDUCTIONS

Four-high stacking of the K-line 600-amp breakers is made possible by one-third reduction in height of this breaker.

Height of the 1600-amp size breaker has been reduced by one-fourth. The 225-amp frame size remains essentially the same as that of the previous line.

Compartment width, over the entire line, is two inches less than that of other makes. This makes the entire K-line of switchgear smaller than comparable equipment.

Breaker weight also has been reduced to provide easier handling and permit the use of fewer personnel when replacements or changes are made in installations. The reduction was made possible by the



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We offer a complete line of trolleys built to meet the most exacting requirements. These trolleys are constructed of the finest materials available. No cast iron is used. All shafts are of highest quality alloy steel. All bearings are calculated with a proper life factor for service required as defined by the A. I. S. E. We will build a trolley to fit your special requirements as to gauge, head room, approaches and general arrangement. We also make a complete line of cranes for steel mill use. . . Your inquiries will be welcome.

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Designers and Builders of Electric Overhead Traveling Cranes and Hoists and Electric Revolving Cranes

Catenary Furnaces

A 12,000 lbs/hour Fuel-fired Catenary Annealing Furnace for stainless strip used in line with spray quench followed by descaling and pickling baths.

FURNACE CHARACTERISTICS

Inside Dimensions 50'-0" long x 7'-0" wide x 6'-8 3/8" high

Fuel Input ..... 1,800,000 BTU/hour

Operating Temperature Range . . 1200 to 2250°F

Stainless Strip . . . . . Cold reduced—annealed in gauges from 0.007" to 0.125"

Stainless Strip . . . . . Hot rolled—annealed in gauges from 0.093" to 0.200"

Three (3) zone proportioning control

Complete control over fuel-air ratio to maintain desired atmosphere in furnace

DREVER COMPANY

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new design and by use of recently developed light-weight materials with high strength-to-weight ratios.

Weight of the 600-amp breaker has been reduced 30 per cent. There is a 55 per cent reduction on the weight of the 1600-amp size. The 225-amp breaker weighs virtually the same as before.

STANDARDIZATION

Extensive standardization has been carried out in the new breaker line. While former breakers all looked alike, they were not. Each frame size consisted of more than one hundred major parts—most of which could be used in only one size breaker.

The new line uses six standardized sub-assemblies. Replacement of any new line sub-assembly will be faster than replacement of a corresponding individual part. Thus field servicing will be greatly simplified.

The sub-assembly system also will minimize parts stocking, with attendant inventory problems, and reduce replacement time.

The time required to change over from manual-charging to electrical-charging is greatly reduced—from about one hour with previous breakers to minutes with K-line units.

CLOSED-DOOR DRAW-OUT

The new breakers may be moved to test and disconnect positions without opening the compartment door. This provides maximum cleanliness which is particularly important in dirt-laden atmospheres. It is also a safety protection and keeps aisles clear of compartment doors for the passage of materials handling equipment.

A lift-shutter, which allows insertion of the crank that moves the breaker in and out, can be padlocked in either test or disconnect positions to guarantee complete safety.

The shutter can not be lifted until the breaker is tripped. While the shutter is open, the breaker can not be closed.

The extendable escutcheon slides through the compartment door as the breaker is moved to test and disconnect positions, while a dust seal, surrounding the escutcheon, is held in place by the door.

INCREASED ACCESSIBILITY

Accessibility of overcurrent trips has been greatly increased. Where formerly it was particually impossible to adjust or change trips on electrically-operated types without a major effort, trips on the new line are out in the open and easily adjusted.

Trips also can be changed easily. Where trips for individual phases were separately mounted on former breakers, trips for all three phases in the new 225 and 600-amp breakers are combined on a single molding—one of the six major sub-assemblies comprising the complete breaker.

Trips on the electrically-charged models can be changed in one-fifth the time formerly needed. The time for changing trips on manual units has been cut in half.

This quick-change feature is particularly significant in meeting constantly expanding load requirements. When loads expand beyond the capacity of trips installed on breaker, changing the trip units will be easier on the new breakers than on any other breaker presently available.

When trip-changing formerly required the services of field engineers, it now is entirely feasible for the user to make his own changes.

The trips of the new line are changed from the rear, compared to front-servicing on the previous line. Misalinement, during replacing or changing of trips, is now practically impossible. Tripper bars are factory-alined in special precision jigs.

TRIP FLEXIBILITY

The K-line breakers provide a new simplification in the use of trip units. Only nine units are required in the new line, compared to the 23 used in the previous line.

Each trip can be used over a wider range of continuous load conditions. Last minute changes in load capacity can be met, in many instances, with an existing breaker and trip as a result of this new setup of trip settings.

This grouping has been established, for example, for the new 1600-amp breaker:

1600 1200 1000 } one unit	1600-amp continuous rating—calibrated from 800 to 2000 amperes.
800 600 500 } one unit	800-amp continuous rating calibrated from 400 to 1000 amperes.
400 300 250 } one unit	400-amp continuous rating calibrated from 200 to 500 amperes.
225 200 150 } one unit	225-amp continuous rating—calibrated from 120 to 280 amperes.

The new line of low voltage power circuit breakers, in addition to the new K-225, K-600 and K-1600 models, also includes the model KD, a 3000-amp rating, and the KE, a 4000-amp frame size.

Figure 3 — Breaker can be moved to test and disconnect positions without opening compartment door. Drawout is accomplished by turning small crank which is inserted through lift-shutter opening in breaker escutcheon.

Figure 4 — Accessible trips, on both manual and electrical types, provide a new ease of adjustment. All three trips for this 600-amp breaker are mounted on a single molding which is one of the breaker's six major sub-assemblies.

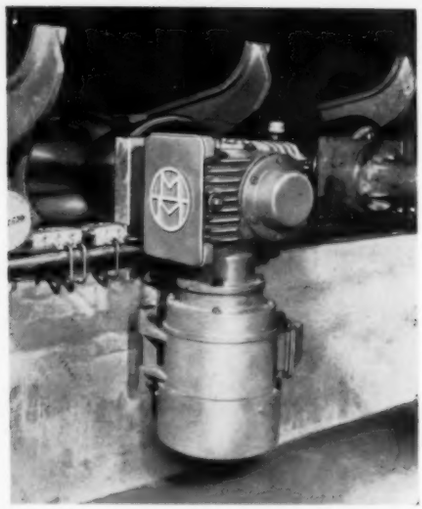


Figure 1 — A standard individually motorized conveyor unit was used on the seamless tube mill.

New Seamless Tube Mill Uses Almost 600 Double-Enveloping Gear Reducers

▲ THE use of individualized motor-reducer drives throughout the new automatic push-button seamless steel tube mill of Mannesmann Tube Co. in Sault Ste. Marie, Canada, is extensive. In developing these drives Mannesmann early settled upon the use of double-enveloping worm gearing—to assure maximum load-carrying ability, maximum life, and minimum service troubles. Experience with that form of gearing since the opening of the mill several months ago has amply justified the decision. Close to 600 of these reducers (produced by Cone-Drive Gears, Division of Michigan Tool Co.)—ranging in capacity from one to 60 hp (at 870 rpm) are in use. All speed reducers are standard, and housings are of ductile iron, except for the welded steel hollow-shaft unit shown in Figure 3.

The mill is designed for automatic production of seamless steel tubing ranging from 4½ to 10¾-in. finished outside diameter. Tube sizes range up to 50 ft in length and billet weights up to 3000 lb each. Rate of tube production is approximately three lengths per min. An extension designed to handle N-80 pipe is under construction alongside the present mill, and this department will utilize over 100 additional cone-drive speed reducers—bringing total to over 700.

Figure 1 shows closeup of one of the standardized individually

Figure 2 — Conveyor not only moves billets but removes some of the scale.

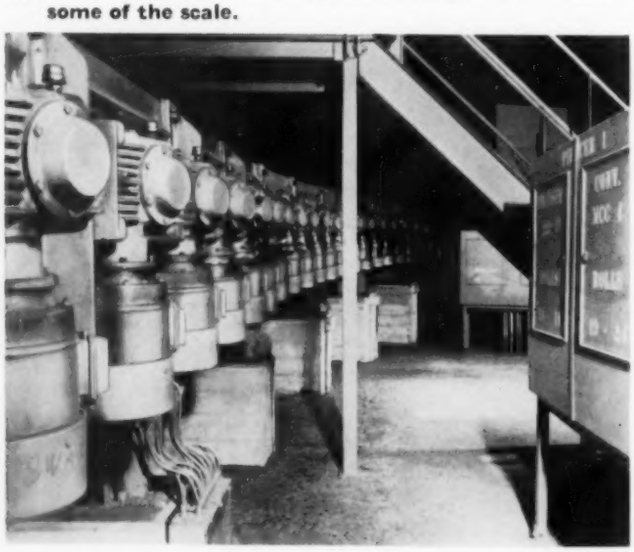
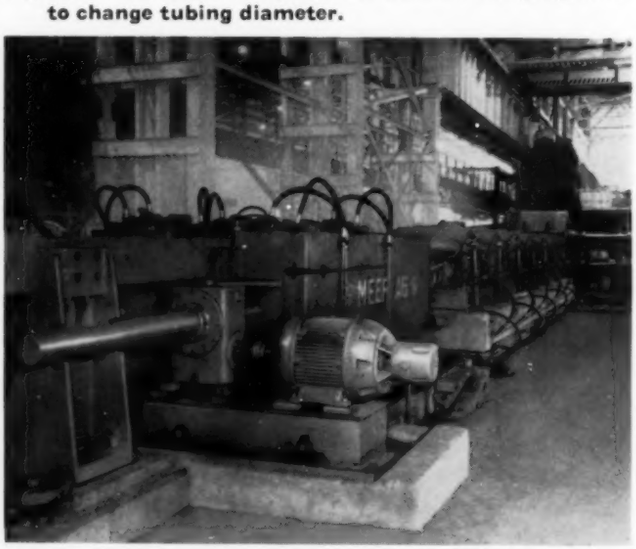


Figure 3 — A wedge adjustment is used on the plug mills to change tubing diameter.



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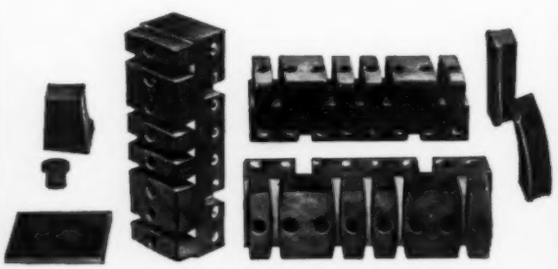
B&W Silicon Carbide Rolls

B&W Silicon Carbide Recuperator Tubes



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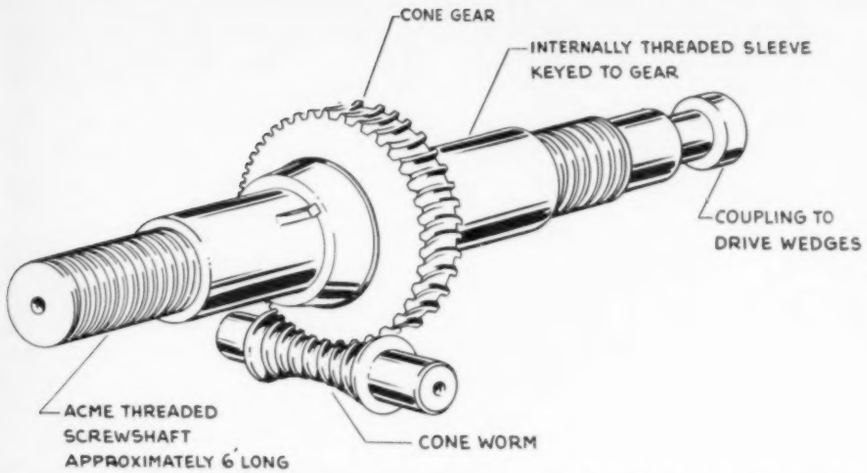


Figure 4 — A double-enveloping gear reducer is the key feature in the wedge adjustment.

motorized conveyor units developed by Mannesmann Tube Co., Ltd. for its push-button seamless steel tube mill in Sault Ste. Marie, Canada. Close to 500 of these conveyor units are now in use at the mill, conveying the steel between all operations from unloading dock and billet cut off, into and out of the rotary furnace and complete tube processing in both the hot and cold sections of the mill.

Basic elements are a 1½-hp, 1150-rpm Canadian General Electric motor directly coupled to a standard 3-in. center-distance cone-drive hollow-shaft speed reducer using double-enveloping worm gearing. Reducer and motor are "hung" on the "V"-groove roll shaft, which is journalled in pillow blocks.

Most conveyor rolls are of "V"-groove design to guide the steel billets and tubes. In the section between the furnace and the first piercing mill, however, there are a number of cylindrical rolls for billet transport over a curved conveyor section with side guides. The conveyor arrangement is such as to rotate the billets during forward movement, thus effectively knocking most of the scale from the billet before it reaches the piercing mill.

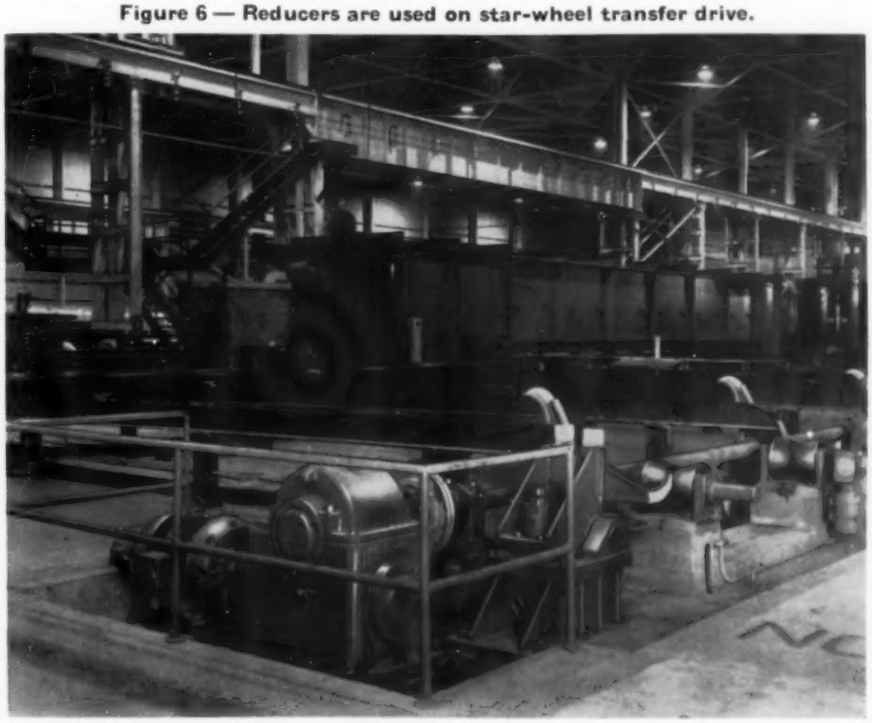
Motor speed is 1150 rpm for all roll drives. Most common reduction ratio in the reducers is 10:1, giving a roll speed of 115 rpm. Where different conveyor speeds are required, this is taken care of by the ratio of the reducer (ratios used range from 5:1 to 40:1). Motor is coupled to the roller conveyor base through a torque arm. The "MM" nameplate is welded to the standard mounting pads of the finned cone-drive reducer housing, which is made of ductile iron. The particular conveyor drive unit shown in Figure 1 is on the conveyor that takes the cold bars from the burning machines to the furnace.

Figure 2 shows a section of the hot-mill conveyor which takes the billets from the furnace to the first piercing mill. This conveyor has the added responsibility of knocking the scale from the billet while turning a corner and raising the billets several feet. With hot billets weighing up to 3000 lb each—and up to 16 ft long—traveling over this conveyor at the rate of three a minute in normal production, the conveyor units get little chance to cool, and service is particularly severe. Used here are 5:1 reduction standard Cone-Drive double-enveloping worm-gear reducers. The rolls are mounted at an angle to the direction of travel to spin the billet while conveying it and help remove the scale.

One of the most unusual of all services in the mill is the wedge adjustment of the plug mills for diameter of tubing (Figure 3). The diameters range from 4½ to 10¾-in. finished outside diameter. Adjustment is made by moving a

Figure 5 — Transfer skid between cut-off machines and main cold mill conveyor.

Figure 6 — Reducers are used on star-wheel transfer drive.



series of wedges by means of a six-ft long threaded shaft. The threaded shaft is turned by Acme threads machined on the inside of a sleeve in the hollow shaft of a compact speed reducer. It has a center distance of only 7 in. Reduction is 40:1 to the gear, from a 15-hp, 900-rpm special high torque reversing electric motor. Rating of the reducer is 7.6 at 870 rpm, Class 1 service, testifying to the momentary overload capacity of the gearing. To assure satisfactory operation, the entire plug mill was assembled in Germany before shipment, to speed reducer having been shipped to Germany (4500 miles) from the plant in Traverse City, Mich., located only 140 miles from the final site of the tube mill.

Figure 4 illustrates the internal working parts of the hollow-shaft reducer used for the plug mill adjustment drive. Acme thread inside of the sleeve rotates the threaded shaft used to move the giant wedges. There are seven wedges, each representing a load of well over 600 lb for a total load of over two tons.

Nearing the end of its travel through the automatic mill (Figure 5), a 6-in. diam tube is shown on a transfer skid between the cutoff machines and the longest conveyor in the mill—the main cold-mill conveyor. An idea of the number of individual standard conveyor drives in the Mannesmann plant is given in this view of just one conveyor.

One of the severest of all services in the mill are the star-wheel transfer drives. To transfer tubes and billets from conveyors to subsequent operations, or from one conveyor to another (generally), three-armed star-wheels are used. All star-wheels in each group are mounted on a common shaft and are rotated one-third revolution each cycle. Since the star-wheel must pick up the heavy workpiece, raise it above the level of the transfer unit, and then place it onto the transfer skids in about one second, shock loads are very high. Over 70 cone-drive standard HU reducers are used to absorb the shock encountered on these drives. Depending on the severity of the service in each location, the reducers range from 7-in. to 12-in. center distance. The drive may be at one end of the star-wheel shaft, but is usually located near the center of the shaft. In either case, the drive units must have maximum freedom from operating difficulties. The motor in the photo is a 25-hp, 900-rpm special high torque unit, driving a 12-in. speed reducer.

Better service is expected from the design since in double-enveloping gearing, the worm envelops the gear as well as the gear enveloping the worm. (In conventional worm gearing only the gear tooth envelops the worm). The result of double-enveloping is to greatly increase contact area per tooth (full-depth) and also put more teeth in contact. In cone-drive gearing one-eighth of all gear teeth (regardless of total number) are in continuous contact with the worm threads. The design provides two options as compared to cylindrical worm gearing:

1. Decrease size of reducer required to handle a given load.
2. Ability to increase greatly the load capacity without any increase in size.

In addition, greater smoothness of drive due to increase continuous contact is provided.

In AUTOMATIC PLATE HANDLING it's ENTERPRISE that counts

A new Enterprise plate handling system replaces a four-man hand-feed operation at the H. K. Porter Company, Inc. breakdown mill, Riverside-Alloy Metal Division, Riverside, N. J.

Handling 20,000-lb. stacks of plates, the system consists of hydraulically-operated entry and delivery tables, a mill feed pusher, automatic cross pushers for plate stacks, and an electric transfer car.

In addition to the design and building of automatic entry and delivery equipment for rolling mills, The Enterprise Company makes roller plate and sheet levelers, mill-type friction saws, roller conveyor units, cooling beds, and other special machinery for steel and pipe mills.

ESTABLISHED 1878

THE ENTERPRISE COMPANY

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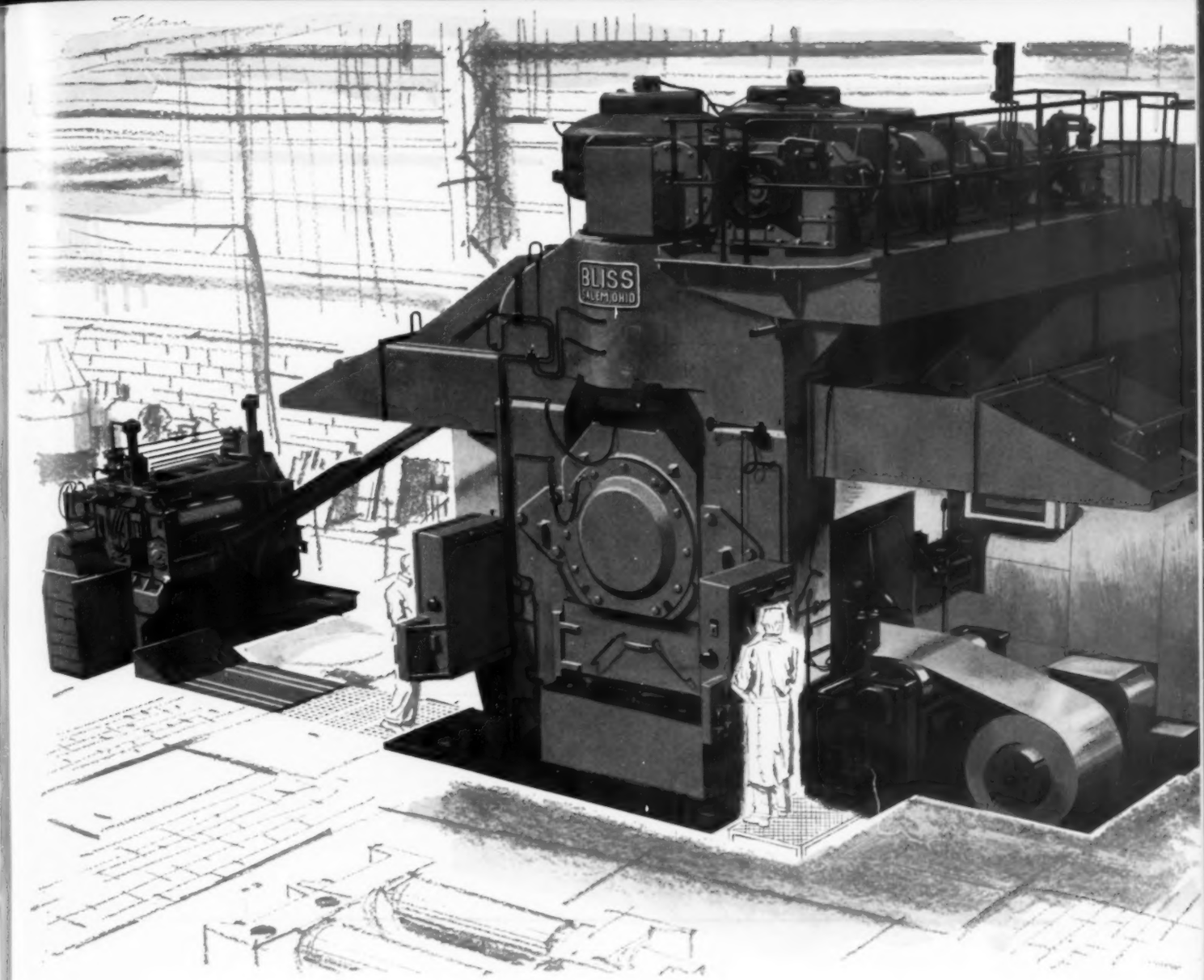

Belgian plant comes back to Bliss for another mill

The Phenix Works, Societe Anonyme, of Flemalle-Haute, Belgium, has just installed its second Bliss mill, a big four-high reversing type that will greatly increase the plant's output of cold rolled sheet products.

The mill has 16" and 53" by 48" rolls, a maximum speed of 2000 feet per minute and coil handling equipment for 30,000-pound, 64"-O.D. coils. It is being used to roll both sheet products and tinplate.

Phenix Works put in its first Bliss mill seven years ago. The second installation is the logical outcome of the company's experience with Bliss equipment and engineering... additional evidence that "The Free World rolls on Bliss mills."

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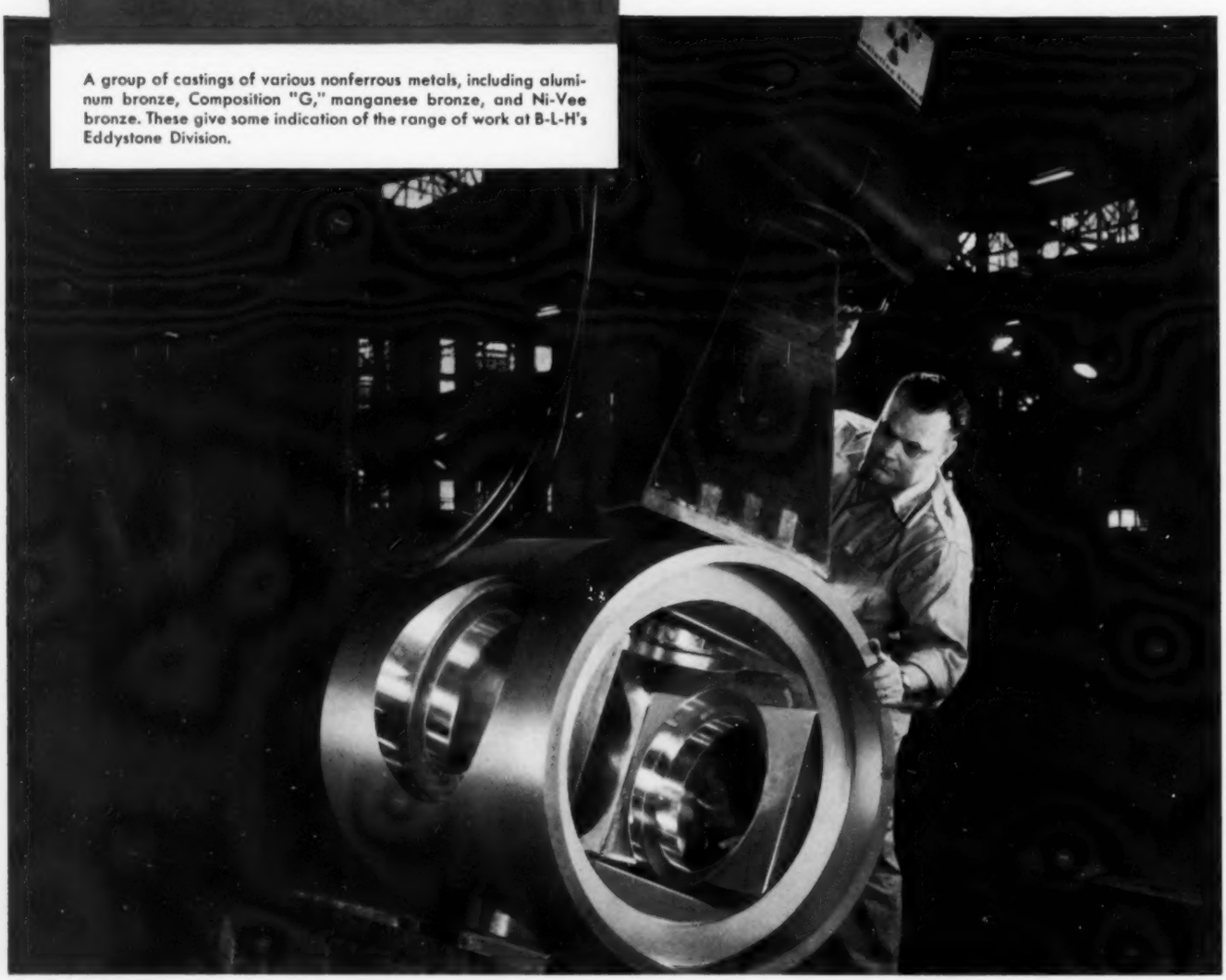
Subsidiary: The Matteson Equipment Company, Inc., Poland, Ohio

Baldwin X-rays castings to insure strict quality control

A group of castings of various nonferrous metals, including aluminum bronze, Composition "G," manganese bronze, and Ni-Vee bronze. These give some indication of the range of work at B-L-H's Eddystone Division.

At Baldwin, quality control is not something we merely pay lip service to. Completely equipped chemical and physics laboratories enable us to make it a tangible, vital part of our services. When specified, we subject your castings to rigid X-ray examination and we are thus able to assure you of their quality. In addition to X rays, we also employ the electron microscope and the spectroscope where specified.

Job shop or high production foundry work, castings of many alloys and compositions weighing from ounces to 95,000 pounds . . . whatever your needs, Baldwin can satisfy them. For a copy of our illustrated Foundry Bulletin 6002, write us today.



Hub of a controllable pitch propeller under the eye of a 220 kvp, 9 milliampere General Electric mobile X-ray unit at the Eddystone Division of B-L-H.

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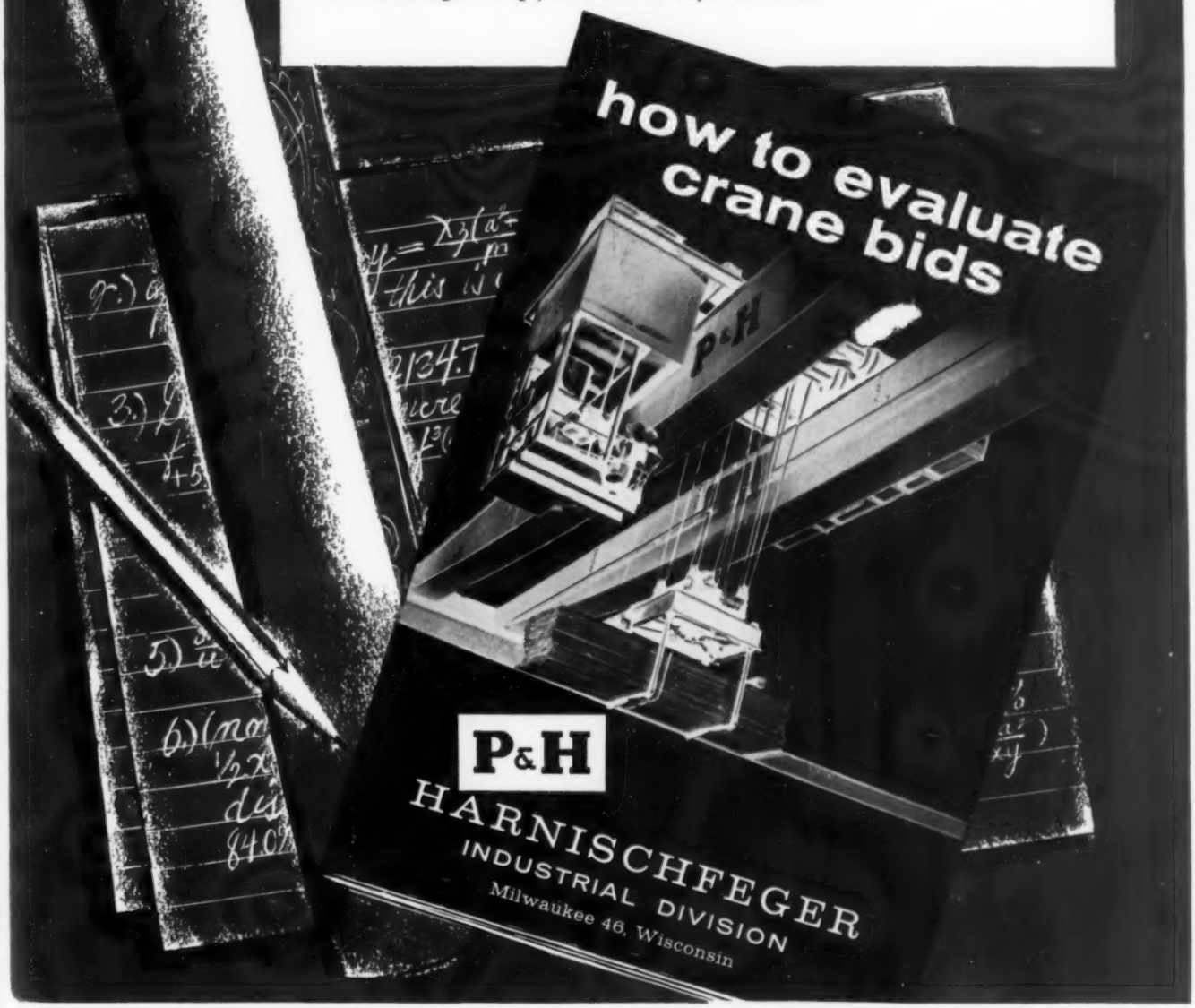

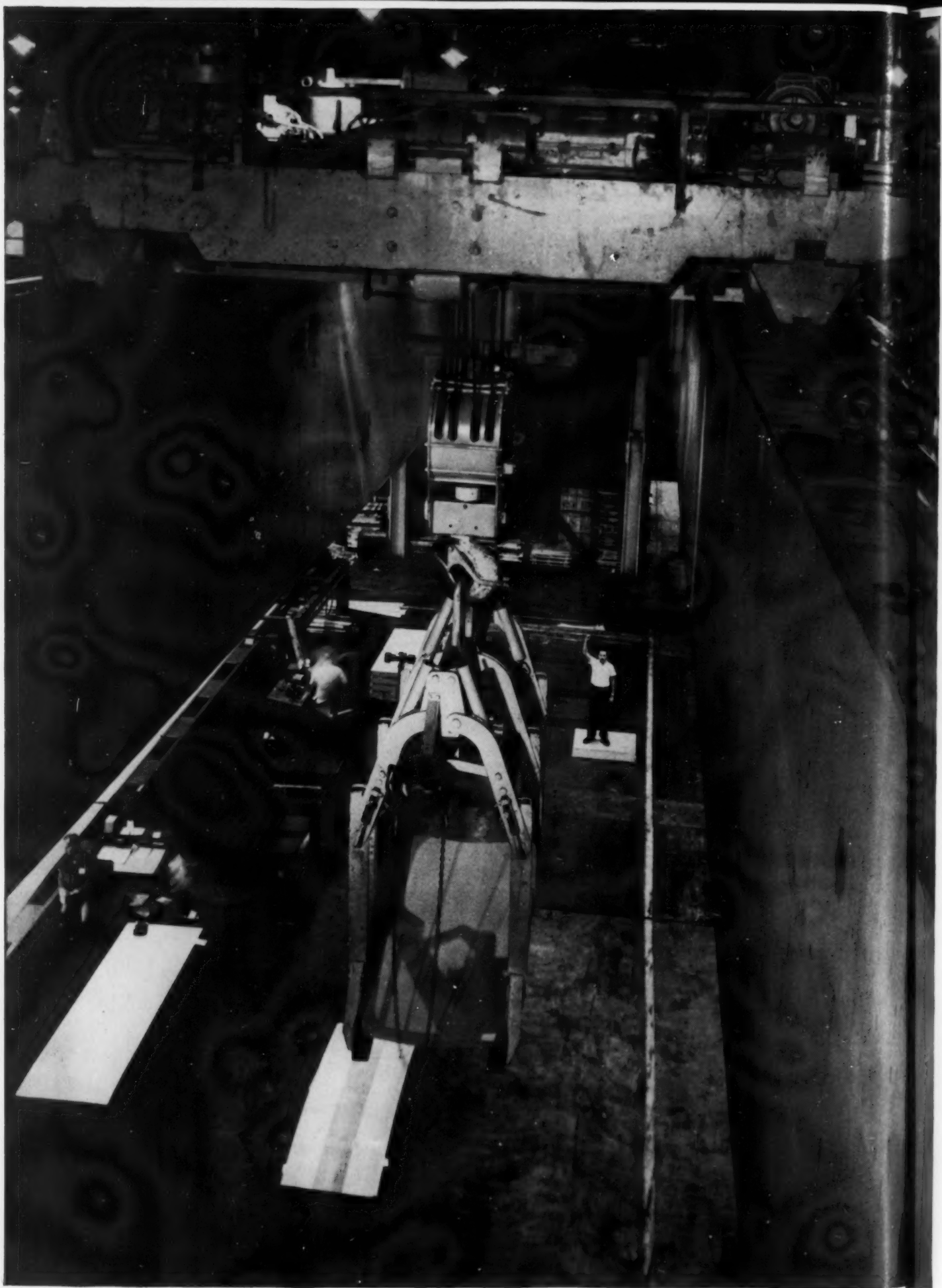

NO DOWNTIME ... NO LOSS IN PRODUCTION

reports Weirton Steel Co.* of its 30-ton crane equipped with Westinghouse motors, brakes and control

Full operating efficiency 16 hours per day 6 days a week . . . that's the kind of dependable service Weirton Steel's zinc plating mill at Weirton, West Virginia has received from this 30-ton crane equipped with Westinghouse motors and control.

Used to move 6,000-lb. bundles of zinc plates in a synchronized timing operation from the shear line to the packaging area, not a single breakdown has ever occurred . . . no production has been lost.

Rugged, compact, and easy to maintain, Westinghouse Silicone-insulated Hevi-Duty Mill Motors allow quick starts, stops, reverses . . . permit slow, smooth operation at no load and at full load. With Westinghouse controls, each unit in the crane system —hoist, trolley, and bridge—moves in the right direction and at the speed necessary for controlled coordination with overall plant operation. Exclusive Westinghouse self-adjusting dc magnetic brakes assure smooth, positive braking with any load—light or heavy.

When you are considering new or replacement crane drives, look to Westinghouse for the exact system required for your particular operation. For complete information, contact your Westinghouse sales engineer, or write Westinghouse Electric Corporation, Box 868, Pittsburgh 30, Pennsylvania. J-22064

*Division of National Steel Corp.

YOU CAN BE SURE...IF IT'S

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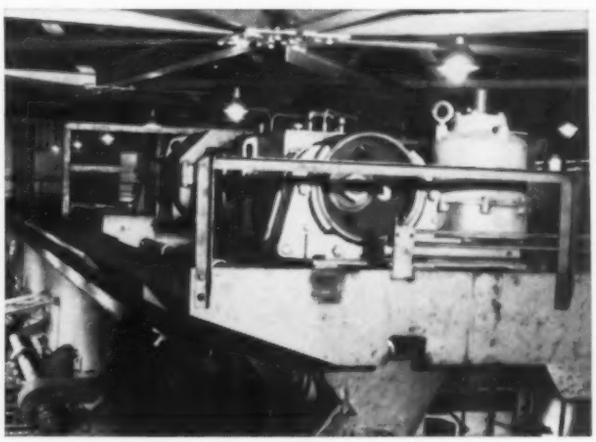
Westinghouse class 9635 and 9605 crane controls are specifically designed for applications requiring heavy-duty electrical equipment. The combination of a well-engineered unit and rugged components assures long dependable operating life.



Type SA dc magnetic brakes by Westinghouse are completely self-adjusting . . . reduce lining wear . . . never need future adjustments. With Westinghouse Silicone-insulated MC 600 mill motors, higher maximum safe speeds are obtained.

how much could you add to your profit-- by saving $50,000 per boiler cleaning?

Here's An Example Of Such A Savings Made Possible By Dowell Chemical Cleaning Service

Dowell recently chemically cleaned a 1,000,000 lb. per hour steam generator for one of its customers. Total outage time was 48 hours. This saved the company an estimated five to seven days down-time, as compared to mechanical cleaning methods.

Considering replacement power for a boiler of this capacity costs between $7,000 and $15,000 per day, it's easy to see a $50,000 savings. And, it's just as easy to project a $250,000 to $500,000 annual savings for a plant with five to ten such boilers.

This particular case history concerns a power company with a forward-looking operations manager. But, Dowell has other startling performance data to show you — from your own industry. That's because chemical cleaning is so versatile. Dowell engineers are experts in removing scale and sludge from process systems, tanks and piping. They apply solvents in various ways— such as filling, jetting, cascading. Dowell furnishes all the necessary chemicals, trained personnel, pumping and control equipment.

For specific information on how chemical cleaning can help you to greater profits, call the Dowell office near you. Or write Dowell Incorporated, Tulsa 1, Oklahoma.

25 years forward

have Dowell clean it chemically

DOWELL

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Date-line Diary...

October 2

▲ Prices of steel scrap declined $2 a ton in Pittsburgh, with No. 2 heavy melting down to $37.

▲ Budget Director Brundage reported revised projected government spending and revenues for fiscal 1958 seem to rule out any tax cuts effective before mid-1958. Projected outlays are now $72,000,000,000, about $200,000,000 more than estimated last January; revenues were put at about $100,000,000 below the $73,600,000,000 January estimate. Surplus is now estimated at $1,500,000,000.

▲ Consumers' installment debt in August, 1957 was increased by $346,000,000 compared with increases of $355,000,000 in July, 1957 and $347,000,000 in August, 1956. Total installment debt is now above $33,000,000,000, or $2,400,000,000 higher than a year ago.

October 3

▲ According to the F. W. Dodge Corp., contracts for future construction in the United States totaled $2,817,966,000 in August, 1957, down 5 per cent from August, 1956.

▲ August Thyssen report gross sales for the first six months of the 1956/57 fiscal year reached a monthly average of $16,250,000. Crude steel production will reach 2,800,000 metric tons later in 1957.

▲ The Bureau of Mines, U. S. Department of the Interior, reported that production of iron ore in the United States for June and July, 1957 totaled 14,439,683 and 14,303,000 long tons respectively; shipments in June and July, 1957 totaled 16,074,328 and 15,885,550 long tons.

▲ The Aluminum Assn. reported that shipments of aluminum sheet and plate in August, 1957 totaled 102,503,000 lb, compared with 119,226,000 lb in July, 1957; shipments of aluminum foil in August, 1957 amounted to 15,740,841 lb, in July, 1957 shipments were 15,011,369 lb.

▲ Government figures showed that manufacturers sales rose to $80,900,000,000 in the second quarter; an increase of 2 per cent over the first quarter and up 5 per cent over the second quarter last year; net after taxes, due to increasing costs, were $4,100,000,000 equal to the first quarter of 1957 and less than the $4,200,000,000 profit for the same period in 1956.

October 4

▲ The National Coal Assn. reported that the soft coal production for 1957 is now indicated at 500,700,000 tons, the third time the estimated production has been reduced from the 532,000,000 tons initially estimated.

▲ Charles E. Oakes, president of Pennsylvania Power & Light Co., told the Pennsylvania Electric Assn., that electric utilities will have to undertake $45,000,000,000 additional financing to meet expansion needs by 1970, basing his prophecy on an anticipated population in 1970 of 200,000,000 and gross national product of $600,000,000,000.

▲ USW and Tennessee Coal & Iron Div., of U. S. Steel Corp. reached an "understanding" ending a 10-day walkout protesting a reallocation of workers and duties, as a result of modernization of underground ore-mining operations.

▲ Two-thirds of the creditors of bankrupt Northeastern Steel Co. of Bridgeport, Conn., have voted to accept a plan for sale of the company to the Carpenter Steel Co. of Reading, Pa. The plan has been approved by U. S. District Judge Robert P. Anderson and a hearing has been scheduled to determine whether transfer of Northeastern's assets will be done immediately or deferred.

▲ According to the AISI, estimated payroll for the iron and steel industry for August, 1957, amounted to $343,730,000 compared with $334,600,000 during July, 1957. Estimated total employment was 663,100 compared with 665,300 during July. Average hourly payroll cost per wage earner was $2.990, a record high level, compared with July cost of $2.983. Average hours worked a week was 36.5 compared with 34.8 in July.

▲ The AISI reported that shipments of finished steel products for the first eight months of 1957 totaled a record 56,392,714 net tons, shipments in the same period of 1956 totaled 53,800,000 net tons.

▲ The Bureau of Mines, U. S. Dept. of the Interior, reported that marketed production of natural gas in the United States for the second quarter of 1957 amounted to 2,550,200,000,000 cu ft, an increase of 6 per cent over a year ago.

October 7

▲ The AISI reports that the operating rate of the steel industry for the week of October 7 is scheduled at 81.6 per cent of capacity. This is equivalent to 2,088,000 tons compared with 2,115,000 tons one week ago and 2,438,000 tons one year ago. Index of production for the week is 130.0.

▲ Government figures showed that construction outlays for September, 1957 was slightly above $4,600,000,000, which is one per cent over August, and four per cent above September, 1956.

October 8

▲ Base price of carbon steel plate was reduced $8 a ton, to $102, by Lukens Steel; Bethlehem Steel has been quoting $102 as the base price since July.

▲ Production of Canadian pig iron in September, 1957 amounted to 334,419 tons against 295,824 tons in September, 1956; steel ingot production for September, 1957 totaled 378,268 tons compared with 424,764 tons in September, 1956. Production of ingots for the first three quarters of 1957 totaled 3,840,083 tons against 3,857,427 tons in 1956; pig iron output for the first three quarters of 1957 was 2,924,288 tons compared with 2,647,876 tons in 1956.

October 10

▲ Edison Electric Institute reported that electric power distribution last week declined to 11,500,000,000 kwhr, down 133,000,000 kwhr from the previous week.

▲ The American Iron Ore Assn. reported last week's loadings of iron ore totaled 2,926,313 gross tons compared with 2,542,978 the previous week and 2,756,934 in the corresponding week in 1956. Total shipments this year are 72,068,057 gross tons.

October 11

▲ The Labor and Commerce Departments reported total employment at mid-September was 65,700,000,

down 700,000 from the month-earlier level citing relinquishing of summer jobs as the prime factor for the decline; unemployment remained stationary at 2,600,000.

October 14

▲ A walkout of about 2700 steel workers closed down Woodward Iron Co.'s plant which was caused, according to the union, because the company had dismissed some blast furnace electricians for refusing to go into a hazardous place to work. The company alleged the walkout was "illegal."

▲ The AISI reports that the operating rate of the steel industry for the week of October 14 is scheduled at 81.7 per cent of capacity. This is equivalent to 2,092,000 tons compared with 2,105,000 tons one week ago and 2,495,000 tons one year ago. Index of production for the week is 130.2.

October 16

▲ A working agreement has been reached between Koppers Company and Strategic Materials Corp. under which Koppers will provide funds for the operation of Strategic's prototype metallurgical processing plant at Niagara Falls, Ontario, and of its research laboratories at Niagara Falls, N. Y. Payment is being taken in stock.

▲ Copper prices declined again in U. S. and world markets. Custom smelters in U.S. cut charges for the metal to 25½¢ a lb, down ½¢, dealers were reported offering copper at 25¢ a lb; spot copper in London fell ⅛¢ a lb to 22.68¢, Union Miniere lowered its price at New York and Antwerp to 23.60¢ a lb, down nearly 1¢.

▲ Government figures showed that private housing starts in September were 88,000 units, compared with 92,600 in August. These figures represented a seasonally adjusted annual rate of 990,000 units, down from 1,010,000 in August and 1,000,000 in September, 1956.

October 17

▲ The ARCI reports that deliveries of new domestic freight cars in September, 1957 totaled 8450 compared with 8758 in August, 1957 and 3444 in September, 1956. Orders totaled 3257 compared with 3203 in August, 1957 and 3949 in September, 1956. Backlog of cars on order as of October 1 stood at 71,981 cars.

October 19

▲ The Aluminum Assn. reported primary aluminum production in the United States during September, 1957 was 129,277 short tons compared with 143,448 short tons in August, 1957 and 132,316 tons in September, 1956.

October 21

▲ The AISI reports that the operating rate of the steel industry for the week of October 21 is scheduled at 79.9 per cent of capacity. This is equivalent to 2,045,000 tons compared with 2,070,000 tons one week ago and 2,491,000 tons one year ago. Index of production for the week is 127.3.

▲ The Bureau of Mines reported that the consumption of scrap during August, 1957 totaled 5,302,000 gross tons, pig iron used was 5,775,000 gross tons compared with 4,897,752 tons of scrap and 5,558,702 tons of pig iron in July, 1957.

October 22

▲ Industrial Heating Equipment Assn. reports that new orders for industrial furnaces in September, 1957 were $2,337,000, compared with $3,057,000 in September, 1956; orders for induction and dielectric heating equipment in September were $487,000 compared with $1,649,000 in September, 1956.

October 23

▲ New orders for machine tools for September, 1957 amounted to $28,800,000, down 35 per cent from August, 1957 bookings and 63 per cent under bookings for September, 1956.

October 24

▲ The AISC reports that shipments of fabricated structural steel for September, 1957, were 294,719 tons compared with 333,133 tons in August, 1957 and 240,858 tons in September, 1956. Bookings for September 1957 amounted to 194,228 tons compared with 167,083 tons in August, 1957 and 246,617 tons in September, 1956. Backlog on September 30 equaled 2,846,346 tons, approximately 8 per cent under a year ago.

▲ The President's Council of Economic Advisers report that the nation's production of goods and services showed an annual rate in the third quarter of $439,000,000,000, or $4,700,000,000 above the pace in the second quarter; and approximately $10,000,000,000 above the yearly pace in the third quarter of 1956.

▲ U. S. Steel Export Co. announced that export base prices on tin mill products have been reduced by 24¢ to 29¢ a base box of 107 lb.

October 25

▲ Union Miniere reduced prices of copper at New York and Antwerp 0.45¢ per lb to 23.15¢; in London, spot copper rallied ½¢ to 22⅞¢ a lb, from a low of 22⅜¢ last Wednesday.

▲ According to the F. W. Dodge report, 202 economists participating in a current survey indicated concern over the outlook for next year. The four main points evolved from the survey are: total dollar output in 1958, as measured by gross national product, would rise slightly; hourly wage rates would continue to go up in all major categories; the cost of living would continue to rise in 1958, and wholesale prices would also go up, but not quite as rapidly real output (as measured by the Federal Reserve Index of industrial production) will dip in the first half of 1958, then rise slightly during last six months.

October 28

▲ Ford Motor Co. sales for the third quarter of 1957 amounted to $1,400,000,000, netting $1.07 per share; sales for the 1956 period were $868,000,000, 25¢ per share; for the first three quarters of 1957, sales totaled $4,400,000,000 up 37 per cent from the 1956 returns, net profit in 1957 for the 9-month period is $4.22 compared with $2.69 in the same period of 1956.

▲ The AISI reports that the operating rate of the steel industry for the week of October 28 is scheduled at 79.1 per cent of capacity. This is equivalent to 2,024,000 tons compared with 2,052,000 tons one week ago and 2,493,000 tons one year ago. Index of production for the week is 126.0

October 29

▲ Experts of the Independent Petroleum Assn. forecast that domestic oil demand in the U. S. for 1958 will be about 9,200,000 barrels daily, up 3.3 per cent over 1957. The prediction is based on the assumption that business activity in 1958 will be no higher, and in fact decline moderately.

October 31

▲ The Aluminum Assn. reports net shipment of aluminum sheet and plate in September, 1957

STEEL MEN!

FIGURE THE VALUE OF A BALANCED TANK

THE ideal glass furnace is one which can be counted on to wear out evenly and uniformly, giving the operator the *full* potential value of every brick in every part of the tank.

Until a few years ago, however, such a tank was considered an obvious impossibility.

When Corhart Electrocast was first offered to the trade as a much superior glasshouse refractory, our new customers began using it to strengthen those portions of their furnaces which had always been the limiting factors in producing life.

This idea proved successful, but at the end of the fire, the Corhart was usually in such good shape that the natural result was to fortify the next weakest portions. This step-by-step process has now been followed through to its logical conclusion by most of our original customers: namely, the gradual increase of Corhart to a point where the life of the former weak portions approximates the life of the easy-service portions. This ideal construction, with the judicious use of Corhart Electrocast, has led to what is termed "The Corhart Balanced Unit."

A Corhart Balanced Unit can be fabricated for a surprisingly small percentage increase in first cost. *This percentage increase represents only a fraction of the increased life and total tonnage output.*

Corhart Balanced Tanks are now widely used throughout the industry. *More than sixty are now in service*—and this, of course, is in addition to the dozens of installations in which Corhart is used as a spot refractory. Write us today for the complete facts and figures on a Corhart Balanced Tank of *your* company's type. Full designs, specifications and quotations will be gladly furnished, without obligation. *Address:* Corhart Refractories Co., *Incorporated*, 16th & Lee Sts., Louisville, Ky.

QUALITY ECONOMY ENDURANCE

CORHART ELECTROCAST REFRACTORIES

THIS ad appeared more than 25 years ago—in January, 1932. At that time Corhart Electrocast was still so new in the glass industry that only a few of the most progressive companies dared buy it. It was, *and still is*, "one of the world's highest-priced refractories". Yet now its use is practically universal . . .

Today Corhart 104 is new in the steel industry. Like its glass-industry counterpart, it too is "one of the world's highest-priced refractories". Yet it offers open-hearth furnace operators the same opportunities for greater production and lower costs that Corhart Electrocast brought to the glass industry.

May we send you all the facts? Address: Corhart Refractories Co., *Incorporated*, 1622 West Lee Street, Louisville 10, Kentucky, U.S.A., SPring 8-4471.

QUALITY ECONOMY ENDURANCE

CORHART 104 ELECTROCAST REFRACTORY

The words "Corhart" and "Electrocast" are registered Trade Marks which indicate manufacture by Corhart Refractories Company, *Incorporated*. Corhart Refractories Co., *Incorporated*, 1600 West Lee Street, Louisville 10, Kentucky, U.S.A.—Telephone SPring 8-4471.

equalled 96,054,000 lb compared with 102,503,000 lb in August, 1957; shipments of aluminum foil totaled 15,399,121 lb in September, 1957, compared with 15,740,841 lb in August, 1957.

▲ The Assn. of American Railroads reported that loadings last week declined to 703,688 cars, down 13.8 per cent from the comparative 1956 period. Loadings for 1957 to date are 4.5 per cent under 1956 figures.

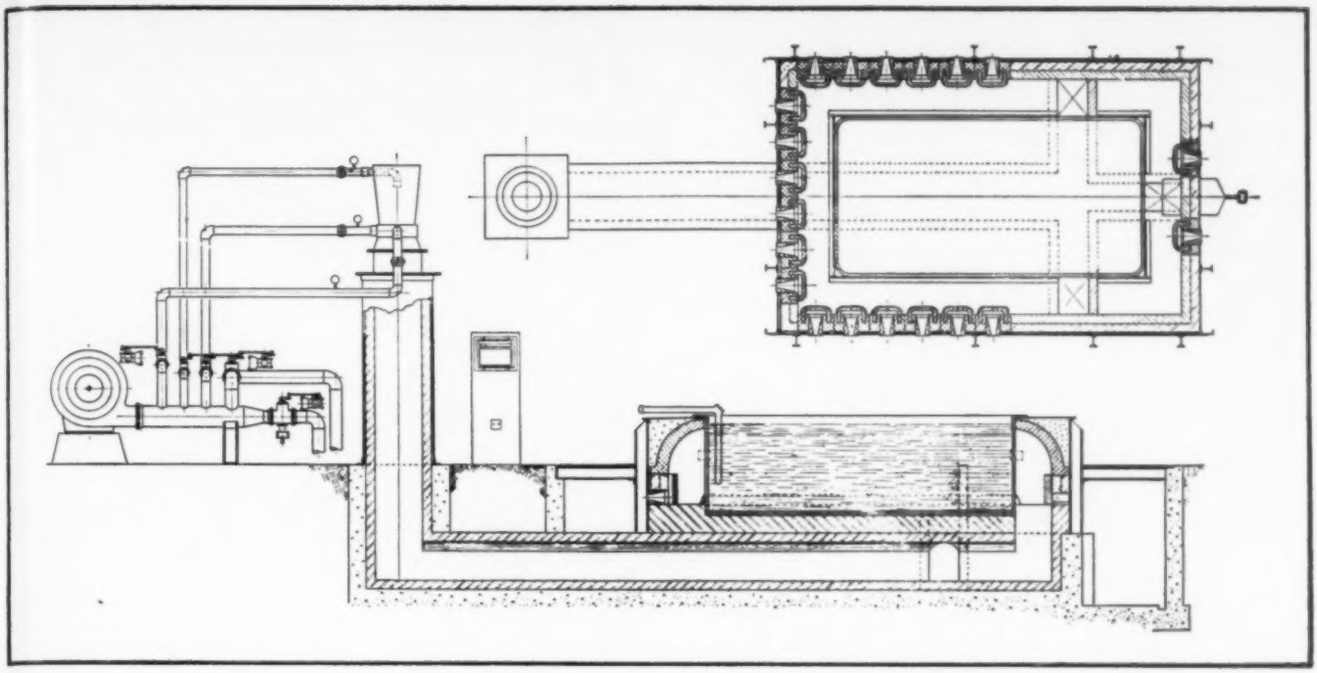
▲ The price of wide flange beams was reduced $5 a ton to $105.50 by Inland Steel Co., and lines up Inland's price with those of other producers in the Chicago area.

▲ Shipments of iron and steel castings during August, 1957 amounted to 1,287,309 short tons compared with 1,133,868 short tons in July, 1957 and 1,337,448 short tons in August, 1956.

STEEL COMPANIES QUARTERLY FINANCIAL REPORTS—ENDING SEPT. 30, 1957

	Period	1957 Net sales	1957 Net profit	1957 Earnings per share	1956 Net sales	1956 Net profit	1956 Earnings per share
Acme Steel Co.	3rd quar.	$ 33,692,937	$ 1,447,145	$0.52	$ 25,858,986	$ 1,016,632	$0.50
	1st 9 mo.	116,322,018	5,388,918	2.18	88,413,944	4,887,840	2.44
Alan Wood Steel Co.	3rd quar.	14,325,642	225,840 (loss)	...	17,010,751	754,266	1.00
	1st 9 mo.	50,691,964	710,178	0.76	51,570,891	2,041,754	2.69
Allegheny Ludlum Steel Corp.	3rd quar.	60,234,127	1,983,861	0.51	48,810,742	556,445	0.15
	1st 9 mo.	213,944,192	9,725,952	2.52	202,598,347	9,647,024	2.56
Armco Steel Corp.	3rd quar.	191,920,645	14,293,811	1.19	163,394,343	9,106,917	0.83
	1st 9 mo.	593,039,675	44,804,103	3.74	558,019,821	46,204,344	4.25
Atlas Steels, Ltd.	3rd quar.	....	168,400	0.16	....	750,000	0.87
	1st 9 mo.	....	1,747,000	1.62	....	2,925,850	3.40
Barium Steel Corp.	3rd quar.	....	123,000	0.03	....	1,929,000	0.56
	1st 9 mo.	....	3,465,000	0.84	87,026,000	4,843,000	1.42
Bethlehem Steel Corp.	3rd quar.	638,698,351	40,051,465	0.86	389,610,779	4,428,143	0.06
	1st 9 mo.	2,002,033,152	143,752,627	3.11	1,659,520,921	99,690,157	2.12
Colorado Fuel and Iron Corp.	3rd quar.	....	3,295,509	0.93	....	371,389	0.06
	1st 9 mo.	....	12,200,223	3.48	....	9,081,359	2.55
Continental Steel Corp.	3rd quar.	....	530,475	1.06	....	609,370	1.21
	1st 9 mo.	....	2,216,785	4.42	....	2,199,774	4.38
Copperweld Steel Co.	3rd quar.	18,111,742	87,202	0.06	21,621,433	621,707	0.73
	1st 9 mo.	69,655,756	1,666,711	1.86	74,021,448	2,495,704	2.97
Crucible Steel Co. of America	3rd quar.	49,524,698	225,119 (loss)	0.06 (loss)	44,195,729	510,226	0.14
	1st 9 mo.	185,829,043	5,820,877	1.60	189,862,560	8,597,020	2.36
Carpenter Steel Co.	1st quar.	12,764,000	948,000	1.10	15,134,000	1,307,000	1.52
Detroit Steel Corp.	3rd quar.	16,564,162	159,889	0.03	29,909,850	2,301,558	0.73
	1st 9 mo.	65,333,846	2,023,853	0.60	93,627,873	6,444,109	2.05
Eastern Stainless Steel Corp.	3rd quar.	9,649,271	....	..	10,838,807	....	..
	1st 9 mo.	37,277,536	1,900,793	2.92	35,942,257	2,525,288	3.88
Firth Sterling, Inc.	3rd quar.	5,446,200	19,500	0.01	6,318,900	59,700	0.05
	1st 9 mo.	22,782,900	831,900	0.57	19,510,200	567,700	0.49
Granite City Steel Corp.	3rd quar.	27,981,573	1,622,303	0.75	32,949,196	3,798,746	1.77
	1st 9 mo.	93,969,833	7,884,259	3.67	104,522,410	11,471,568	5.35
Inland Steel Co.	3rd quar.	184,505,748	13,382,172	2.36	140,642,350	6,529,999	1.17
	1st 9 mo.	591,286,590	43,146,628	7.60	532,991,057	35,490,480	6.34
Interlake Iron Corp.	1st 9 mo.	83,879,513	5,066,277	2.26	77,328,789	5,131,198	2.30
Jones & Laughlin Steel Corp.	3rd quar.	218,470,000	11,377,000	1.46	129,257,000	1,360,000	0.13
	1st 9 mo.	650,828,000	37,970,000	4.88	537,947,000	32,269,000	4.13
Kaiser Steel Corp.	3rd quar.	52,165,931	3,445,155	0.89	....	....	..
	1st 9 mo.	163,940,395	18,353,642	5.13	157,149,134	18,611,733	5.24
Keystone Steel & Wire Co.	3rd quar.	20,731,135	1,145,255	0.61	24,185,230	1,727,715	0.92
Lone Star Steel Co.	1st 9 mo.	76,026,479	9,439,862	3.25	65,000,000 (approx.)	6,891,540	2.37
Lukens Steel Co.	36 wks. ending Sept. 7	91,494,385	8,309,801	8.71	67,699,621	4,262,297	4.47
McLouth Steel Corp.	3rd quar.	....	2,166,371	1.20	....	1,315,910	0.67
	1st 9 mo.	....	7,535,966	4.38	....	6,333,541	3.57
National Steel Corp.	3rd quar.	149,717,037	8,041,074	1.08	133,345,718	6,514,649	0.88
	1st 9 mo.	493,065,495	34,149,921	4.60	480,985,383	35,476,059	4.80
Pittsburgh Coke & Chemical Co.	3rd quar.	13,743,000	825,000	0.62	15,263,000*	700,000	0.52
	1st 9 mo.	40,771,000	2,477,000	1.87	49,383,000*	2,667,000	2.06
Pittsburgh Steel Co.	3rd quar.	44,319,757	654,049	0.21	29,825,249	348,190 (loss)	0.43 (loss)
	1st 9 mo.	141,596,176	4,275,372	2.10	131,734,027	4,432,917	2.19
Republic Steel Corp.	3rd quar.	277,176,474	20,121,297	1.29	203,254,239	4,305,948	0.28
	1st 9 mo.	972,388,549	73,039,194	4.68	890,224,500	55,838,400	3.61
Sharon Steel Corp.	3rd quar.	31,680,070	213,852	0.19	28,403,871	301,507	0.27
	1st 9 mo.	117,175,076	2,943,877	2.67	129,082,858	4,627,139	4.20
Superior Steel Corp.	3rd quar.	6,625,281	69,842	0.20	5,730,740	69,989	0.21
	1st 9 mo.	23,067,831	480,314	1.41	20,718,123	343,450	1.01
United States Steel Corp.	3rd quar.	1,042,782,049	97,555,683	1.70	764,991,210	34,785,870	0.52
	1st 9 mo.	3,379,580,712	328,976,991	5.77	3,034,281,345	243,336,311	4.18
Washington Steel Corp.	4th quar.	....	321,551	0.52	....	499,120	0.82
	Year	....	1,786,398	2.93	....	1,744,288	2.84
Wheeling Steel Corp.	3rd quar.	57,286,000	1,714,000	0.66	42,635,000	525,000	0.04
	1st 9 mo.	196,624,000	9,107,000	4.02	186,703,000	11,924,000	5.54
Woodward Iron Co.	1st 9 mo.	....	2,367,230	1.12	....	5,469,563	2.58
Youngstown Sheet and Tube Co.	3rd quar.	170,304,765	9,890,247	2.88	111,673,695	3,381,000	0.99
	1st 9 mo.	541,671,893	31,814,556	9.25	473,340,204	24,904,653	7.30

* Includes $2,457,000 and $5,262,000 respectively of revenues of Great Lakes Steamship Co., Inc., a subsidiary, subsequently liquidated.



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■ Galvanizing Settings designed and built by Furnace Engineers have shown remarkable economies of operation. In one installation, compared with two other settings, tons of steel coated were increased from 950 to an average of 1,450 tons per month. Fuel consumption was reduced from 1,150 to 875 cu. ft./ton and pot life was more than doubled.

At the same time, quality and uniformity were improved while zinc consumption was substantially reduced.

This case example is typical of the economies to be found wherever F.E.I. Galvanizing settings are used to coat tubes, sheets or metalware.

These economies are the result of the patented baffle type burners and unique eductor type combustion system that automatically control heating. No other combination will provide the fast acceleration and turn-down of heat, plus uniform operating temperatures that improve performance and prolong kettle life.

With 30 years of practical experience, Furnace Engineers is fully equipped to design new settings or convert existing furnaces to this modern high production—low cost method of galvanizing furnace operation.

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FURNACE ENGINEERS BUILDS—

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- **Annealing & Normalizing Furnaces**
- **Direct Fired Cover Type Annealing Furnaces**
- **Galvanizing Settings**

The patented baffle type burners and eductor type combustion control systems are used on all annealing furnaces and galvanizing settings.

Write for this informative folder that completely describes the F. E. I. System.

Furnace Engineers, Inc.

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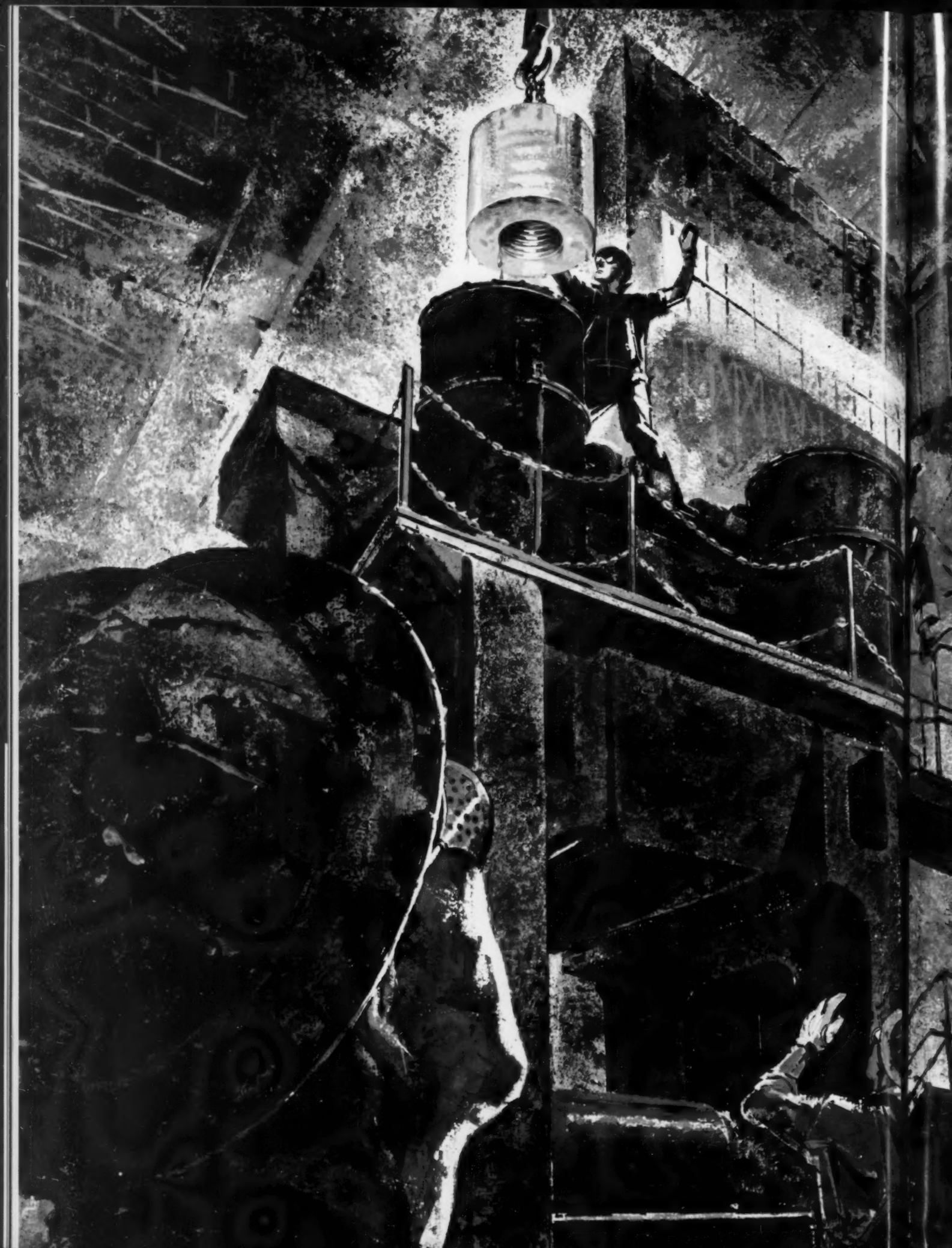

NBD screw nut works 3¼ million tons of steel

Proves value of NBD centrifugal casting for adding extra service life

AFTER working fantastic tonnage . . . 3,266,599 tons to be exact . . . on a universal slabbing mill at United States Steel's Homestead Works, this NBD screw nut was finally replaced as one of a pair. (About 6 months' service life still remained in this nut.)

How can bronze be so tough? NBD makes it that way . . . in the casting, the alloy, the machining accuracy.

Instead of sand casting, we use special centrifugal casting techniques for screw nuts. We get a denser, sounder, higher strength casting . . . with a longer pay-off in rugged steel mill service.

Our centrifugal equipment handles casting weights up to 10,000 lbs.

The only other secret is the bronze alloy we use, and this is where 80 years in the bronze and copper business pays a bonus. We've discovered screw nut alloys that are not only tough enough to take terrific punishment, but are easy on forged steel screws. (The screw used with the nut above is still working, good for another three million tons, as wear to it was negligible.)

NBD precision-machines everything but the screw nut thread, a specialty job for which we have an excellent source.

Call us to talk about screw nuts, stripper nuts, housing nuts—or any other parts in our complete line of steel mill bronze and copper (high conductivity included).

compare your screw nut service with these facts:

Installed: April 6, 1954; replaced February 27, 1956
Finished weight of nut: 7085 lbs.
Screw speed: 17.3 feet/min.
Pressure on screw: 200,000 lbs.
Mill speed: 80 to 120 RPM.
Ingot sizes: from 29″ x 66″ x 110″ to 39″ x 72″ x 105″
Ingot weights: from 47,350 to 74,070 lbs.
Rolled thicknesses: from 3″ to 21″ with max. 66″ widths
Rolling temperature: approximately 2300°F
Principal grades of steel rolled: Std. Open Hearth, Stainless, Manganese, Corten
Total tonnage steel rolled: 3,266,599

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PLANTS IN: CHICAGO • ST. LOUIS • MEADVILLE, PA.

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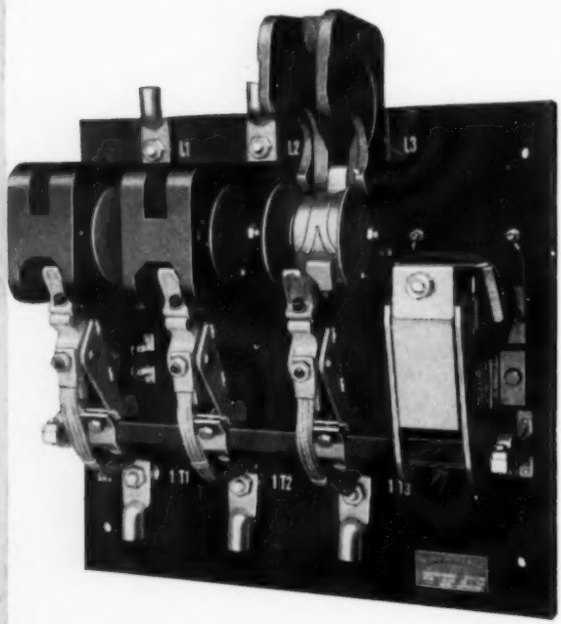

1 *Blows out arc faster.*
2 *Speeds operating cycle.*
3 *Reduces maintenance.*
4 *Operates quietly.*
5 *Lengthens contact life.*
6 *Provides horizontal or vertical mechanical interlocking.*
7 *Combines maximum structural strength with minimum weight.*

While this mill-type contactor was specifically designed for starter, machine-tool and crane applications, it is finding use in all types of service where severe operating conditions place a premium on lasting performance.

WRITE FOR BULLETIN 5005

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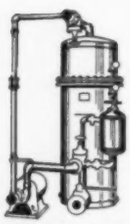
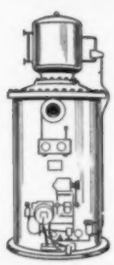
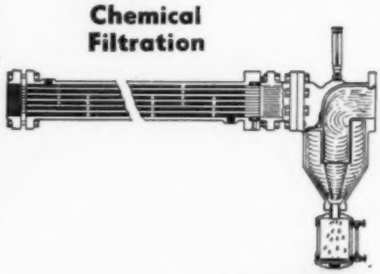


Chemical Filtration



Industrial Water Filtration



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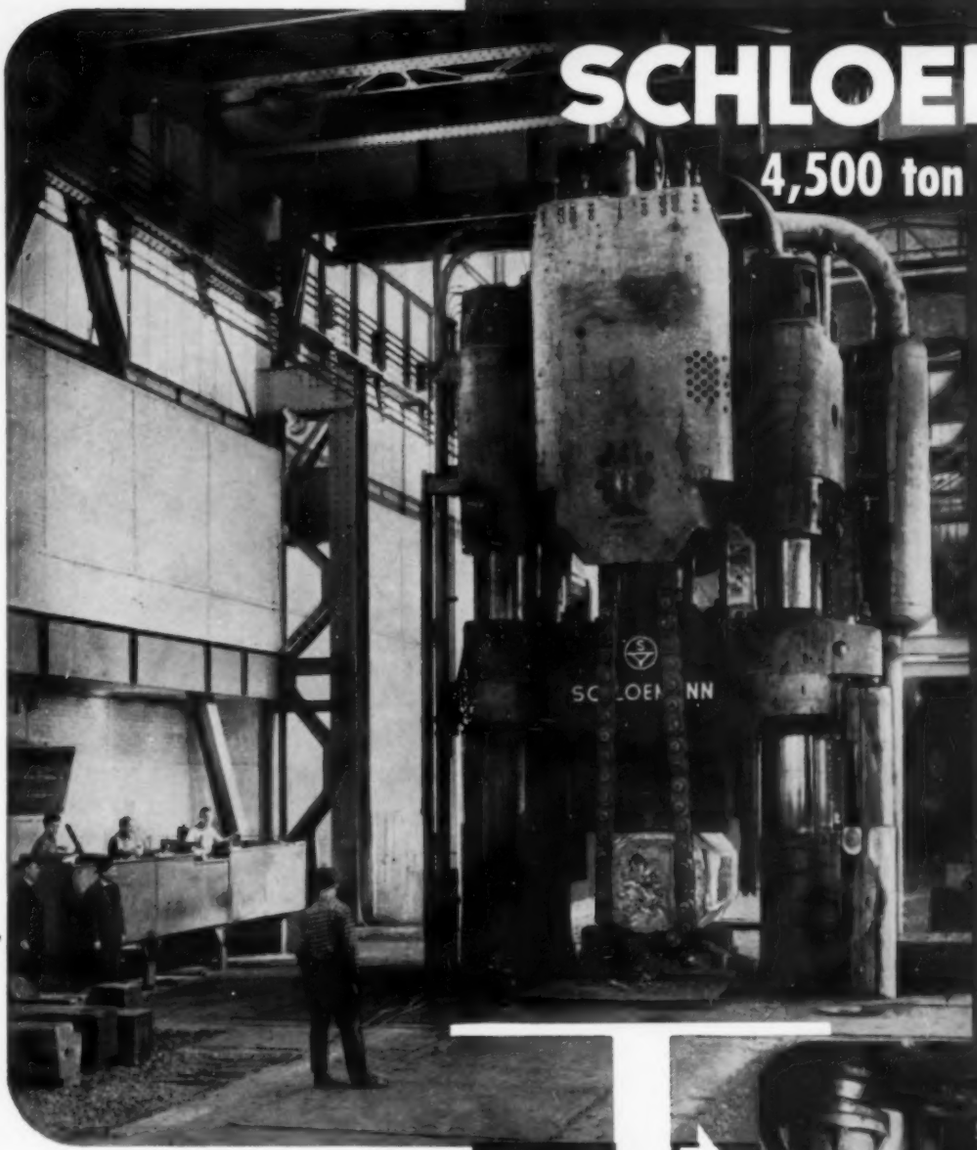

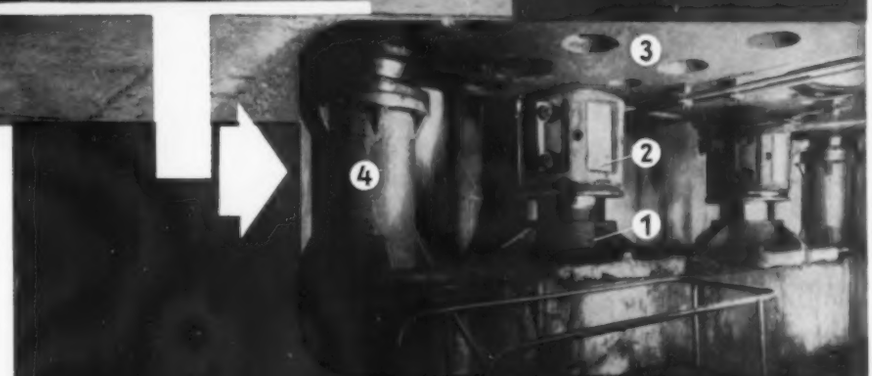

Support of the press on the foundation

1 shoe plate for column
2 column nut
3 anti-splinter
4 support

Electro-hydraulic controls • Rapid switching from normal forging to automatic planishing • Changing of pressure stages, working stroke, and speed of stroke during operation possible • Effective protection of columns from edging and bending effects during off-center work by spherically supported guide bushings in the moving crosshead • Particularly solid and rigid construction, no anchoring so that damage to the press foundation is completely prevented • *Further information supplied on request.*

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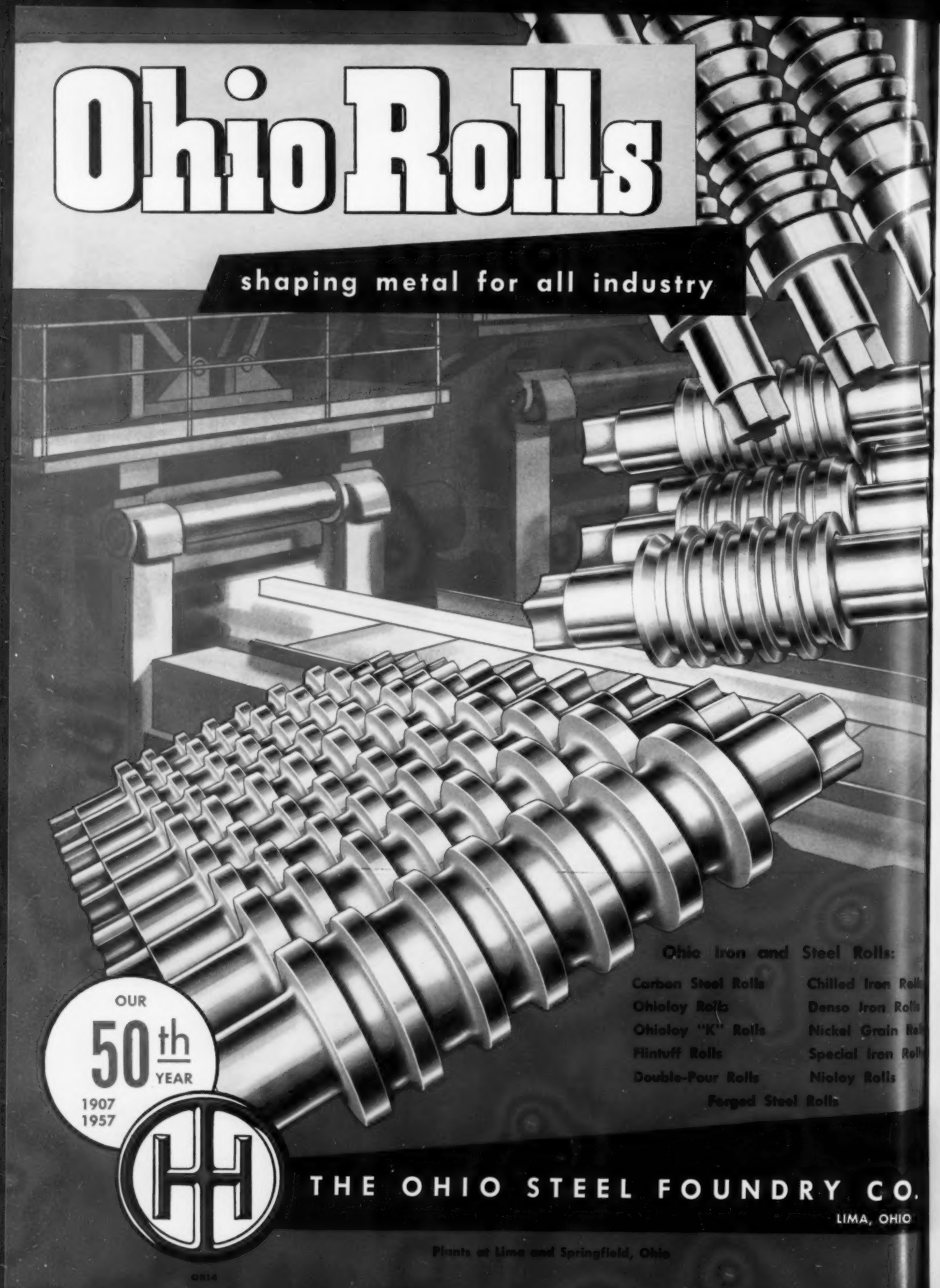
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Industry News...

NEW FAIRLESS BLAST FURNACE CHRISTENED

▲ A new blast furnace, named Patricia, was christened at U. S. Steel's Fairless Works October 28. Miss Patricia Fairless, with her grandfather, Benjamin F. Fairless, former chairman of U. S. Steel Corp., presided over the traditional light-up ceremony attended by civic and company officials.

The new unit, the third blast furnace at Fairless Works, will increase the plant's iron making capacity by 50 per cent. Designed and erected by Arthur G. McKee Co., the Patricia furnace is similar in size and construction to the two original furnaces, having a 28-ft hearth and a 1600-ton daily capacity.

Edgar B. Speer, Fairless Works' general superintendent, said that the addition of the third furnace will eventually increase the plant's annual steel ingot tonnage. It will also make possible greater utilization of the finishing facilities now available at Fairless Works and will permit closer quality control because of the increased supply of hot metal available for the plant's open hearth furnaces. A third furnace will also permit the plant to maintain its production rate when it becomes necessary to reline or repair one of the two original furnaces.

Auxiliary equipment required by the new furnace includes an additional turboblower and boiler in the plant's power house, a new ore bridge, and a 600-ft extension of the present ore yard. The new furnace and both original furnaces are equipped with electrostatic precipitators and primary gas washers designed to keep pace with the present high smoke control standards.

WESTINGHOUSE UNVEILS NEW MAGNETIC STEEL

▲ Scientists at the Westinghouse Research Laboratories in Pittsburgh, Pa., announced a new kind of magnetic steel, called Cubex steel. Described as "doubly-oriented silicon-iron," or "cube-oriented silicon-iron," it is expected to be used in the magnetic cores of electrical devices such as transformers, motors and other electrical equipment.

Announcement of the new material was made by Dr. Clarence Zener, director of Westinghouse research who described the development as "a major scientific breakthrough for the electrical industry."

The unique metallurgical processes involved in preparing the new silicon-iron were originated by scientists at the Vacuumschmelze of Hanua, Germany—a division of the Siemens-Halske Co. Westinghouse research scientists have extended this work and have provided basic information necessary to progress of the material to its present state of development.

In preparing the new material, the Westinghouse scientists revealed they have discovered a new mechanism for crystal growth in metals. As a result, the new silicon-iron has a unique crystal arrangement, contrary to that normally encountered in the metal, and difficult to bring into being.

The crucial characteristic imparted to the new steel by its unusual crystal orientation is an ability to be magnetized easily in four directions. This permits magnetism to readily "turn corners" in the magnetic core of a piece of electrical equipment.

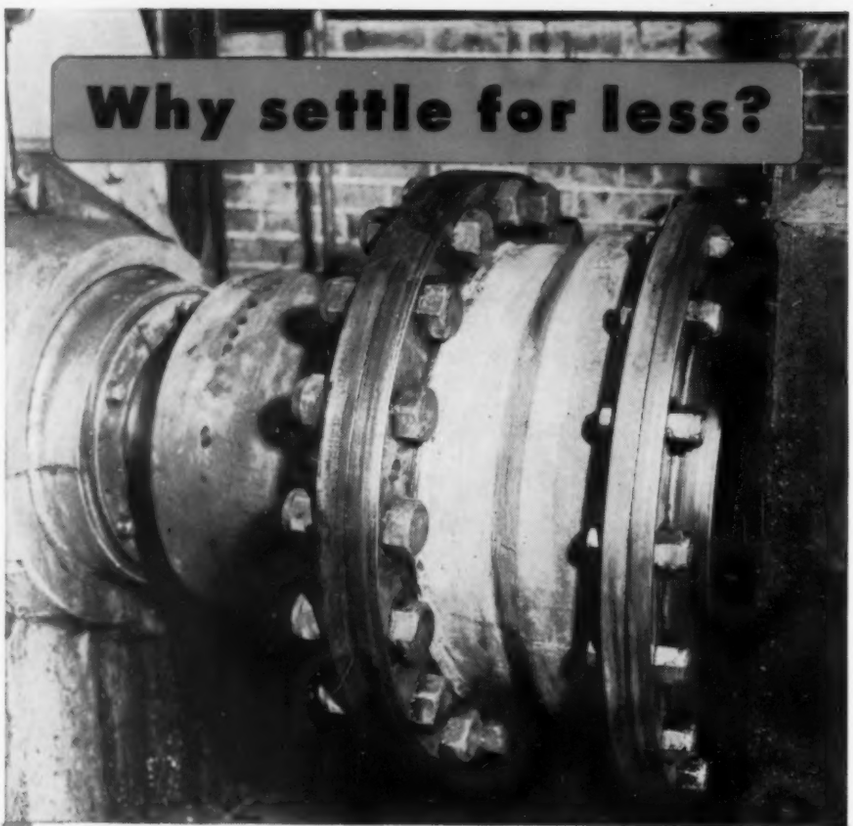
The conventional steel now used in magnetic cores is known as "singly-oriented." It can be easily magnetized in two directions only: that is, back and forth along the direction in which the steel is rolled during its manufacture. For this reason, to provide the best magnetic path all around the rectangular core of a large transformer, the core is built up of straight strips of metal laid at right angles into a rectangular shape.

In the case of the new material, however, "L"-, "E"-, "U"-shaped, or even rectangular punchings, could be stamped from a sheet of steel in one operation. This, in many cases would simplify construction of the core, besides giving an improved magnetic path.

Dr. Zener said that three scientific laboratories were involved in the research and development which produced the new magnetic steel: the Vacuumschmelze laboratory in Germany, the Westinghouse Research

ARMCO SINTER PLANT CONSTRUCTION UNDERWAY

The new sinter plant for Armco Steel Corp.'s Ashland, Ky., operations begins to take shape. Illustration shows part of the circular cooler in the foreground with the main sintering building going up behind it. The new facility being constructed by Dravo Corp., will produce at least 2400 tons of sinter per day.



12" Waldron flexible coupling on a drive for a 12" bar mill.

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STRENGTH —Hubs and cover sleeves for sizes 1¼A through 7A are machined from tough steel forgings. Hubs are keyed to the shafts. The two one-piece cover sleeves function as a single, rigid unit serving as a floating connecting link between the hubs. High strength of forgings makes possible a very compact coupling with low rotating inertia.

RELIABILITY —There are no flexible parts to bend or break and the coupling is dust, moisture, and oil tight. Patented Walflex seal is positioned where centrifugal force is least. Clearance between teeth in hubs and sleeve is engineered so that an oil wedge always separates them, taking the wear.

SERVICE —Plenty of rough bore couplings, already assembled—on the shelf for *immediate* delivery. Finish bored standard couplings shipped to meet customers' schedules. We are geared up to give you realistic delivery on *any* type of couplings.

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Laboratories, and the Westinghouse Materials Engineering magnetics laboratory. The work at the Westinghouse Research Laboratories, he said, was under the direction of Dr. George W. Wiener.

Cubex steel has about the same chemical composition as the standard magnetic variety—about three per cent silicon to 97 per cent iron. The real difference between the two comes from the way the steel is handled during its processing from rough sheet into the final product. The process responsible for producing cube-oriented silicon-iron has been shown to be operative in sheets thick enough to make it feasible for use in large transformers and motors. In thin strip, which is much easier to prepare, it has been made on a pilot-plant scale at the Westinghouse Materials Manufacturing Department at Blairsville, Pa. Such strip, about five thousandths of an inch thick, is of the dimensions used in air-borne transformers, relay cores, and similar electronic and electrical equipment.

Dr. Wiener emphasized that, thick or thin, Cubex steel has not yet "graduated" from the laboratory stage of development. It is difficult to predict yet just how soon it will find general use in the electrical industry. Specialized uses requiring only thin sheet will no doubt be the first commercial applications to be encountered, possibly within the next few months.

DRAVO AWARDED MILL LUBRICATION CONTRACT

▲ Dravo Corp. has been awarded a contract by Blaw-Knox Co. for four mill lubrication systems to be installed on rolling mills of the South Chicago Works of U. S. Steel Corp.

A 50-gpm system will feed 2200–2600 SSU oil at 100 F to a 40-in. by 90-in. two-high reversing mill, screwdown drives, manipulator drives, rack and pinions.

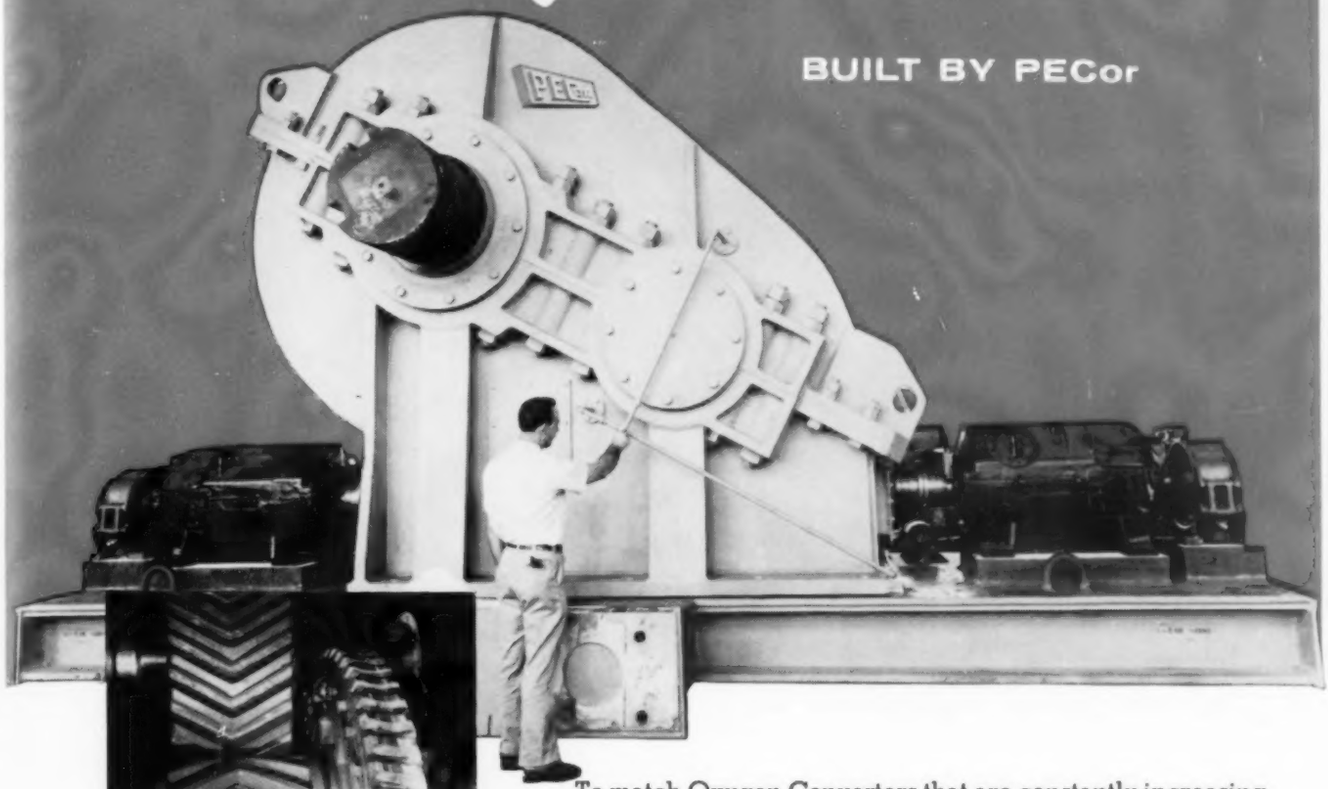
A 60-gpm, 1500–1800 SSU oil, system will service the front main mill table, back main mill table, mill approach table and mill delivery table.

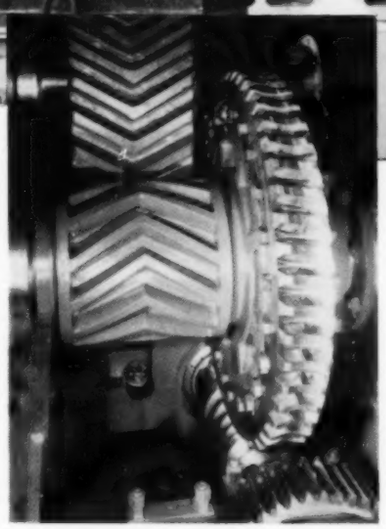
A third system, 130-gpm, 2200–2600 SSU oil will lubricate pinion stands and screwdowns for Stands 1 and 4 on universal beam mills and edging mills.

The fourth system, 170-gpm,

The World's Largest Converter Gear Drive

BUILT BY PECor





- ★ **Totally enclosed and sealed against dirt**
- ★ **Complete anti-friction bearings for peak efficiency**
- ★ **Self-contained lubrication system**
- ★ **Dual motor drive for greater safety and higher availability**

To match Oxygen Converters that are constantly increasing in size, PECor has just completed the largest set of gear drives ever built for their tilting mechanism. Designed for the new J&L Converter installation, this 70-ton drive features the largest cone-worm set yet made for the purpose. The drive unit was so accurately machined and carefully fitted with anti-friction bearings that it could be turned by hand at its completion.

PECor manufacturing facilities are being steadily improved to keep pace with the growing demands for heavier, more efficient equipment of all kinds. When you are in the planning stages, consult PECor for equipment that anticipates requirements of future service. Your guarantee of satisfaction is PECor's leadership for over 75 years.

WRITE FOR COMPLETE PECor CATALOG

This 40-page booklet pictures and explains PECor's facilities and gives many examples of equipment designed and fabricated by PECor specialists.

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OTHER EQUIPMENT WE BUILD—Blast Furnaces . . . Hot Metal Mixers . . . Hot Metal Mixer Cars . . . Ladles . . . Ladle Transfer Cars . . . Scrap Cars . . . Slag Cars. . . Ore Transfer Cars . . . Thermo Metal (Bottle) Cars . . . Jack Cars . . . Ingot Cars . . . Oxygen Converters . . . Electric Furnace Shells and Roof Rings . . . Electric Furnace Charging Buckets . . . Holding and Mixing Furnaces . . . Copper Converters and Holding Furnaces

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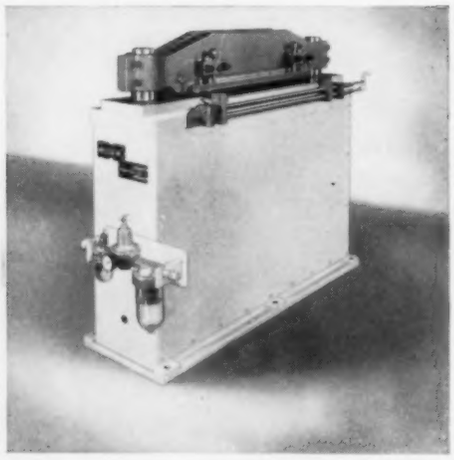
"Complete Processing and Handling Equipment . . . for any Ferrous or Non-Ferrous Material . . . That Starts — or Ends — as a Coil"

Fast, dependable method of fastening the lead end of a new coil to the trailing end of a preceding coil. Entirely automatic. Produces a double row of locked stitches. Practical for strip of any width. Your samples stitched and returned promptly. Also automatic welders.



Fast acting single shears for use with hump tables in cut-to-length and press feed lines, and other applications to square crop the end of a coil. Also twin cut shears that remove the section where two coils were stitched or welded together for continuous processing.

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THE HERR EQUIPMENT CORPORATION

1270 VINE STREET • WARREN, OHIO

CLEVELAND, INDIANAPOLIS AND BERKELEY, CALIFORNIA

2200–2600 SSU oil, will lubricate pinion stands and screwdowns for Stands 2 and 3 on the universal beam mills and edging mills.

EXPANSION WILL BOOST ARMCO'S PIPE OUTPUT

▲ A $1,500,000 expansion to increase production of Armco Steel Corp.'s spiral-welded pipe has been announced.

The expansion, expected to boost pipe output by an additional 2000 tons a month, will take place at the company's No. 2 fabricating plant in Middletown, Ohio, C. G. Davies, vice president of operations, Armco Division, reported.

An 80 by 720-ft building will be constructed to house pipe manufacturing equipment. Two pipe machines, now in operation at fabricating plant No. 1 in Middletown, will be moved to the new site and installed along with other pipemaking equipment.

Mr. Davies described the $1,500,000 expansion as the largest single capital expenditure in the fabricating plant's history. Part of the money will be spent in fabricating plant No. 1 in the relocation of pipe machines and the rearranging of finishing equipment following the transfer of the two pipe machines to the new plant.

The new plant is scheduled to be in operation by April of next year.

In addition to the pipe machines, a new 25-ton overhead crane, a water tester, an end facing machine, generators and other equipment will be installed in the building.

New double switching railroad trackage, water and power lines and roads will be built to serve the new plant.

When completed, the new facility will produce pipe in sizes ranging from 8 to 36 in. in diam and in lengths up to 90 ft.

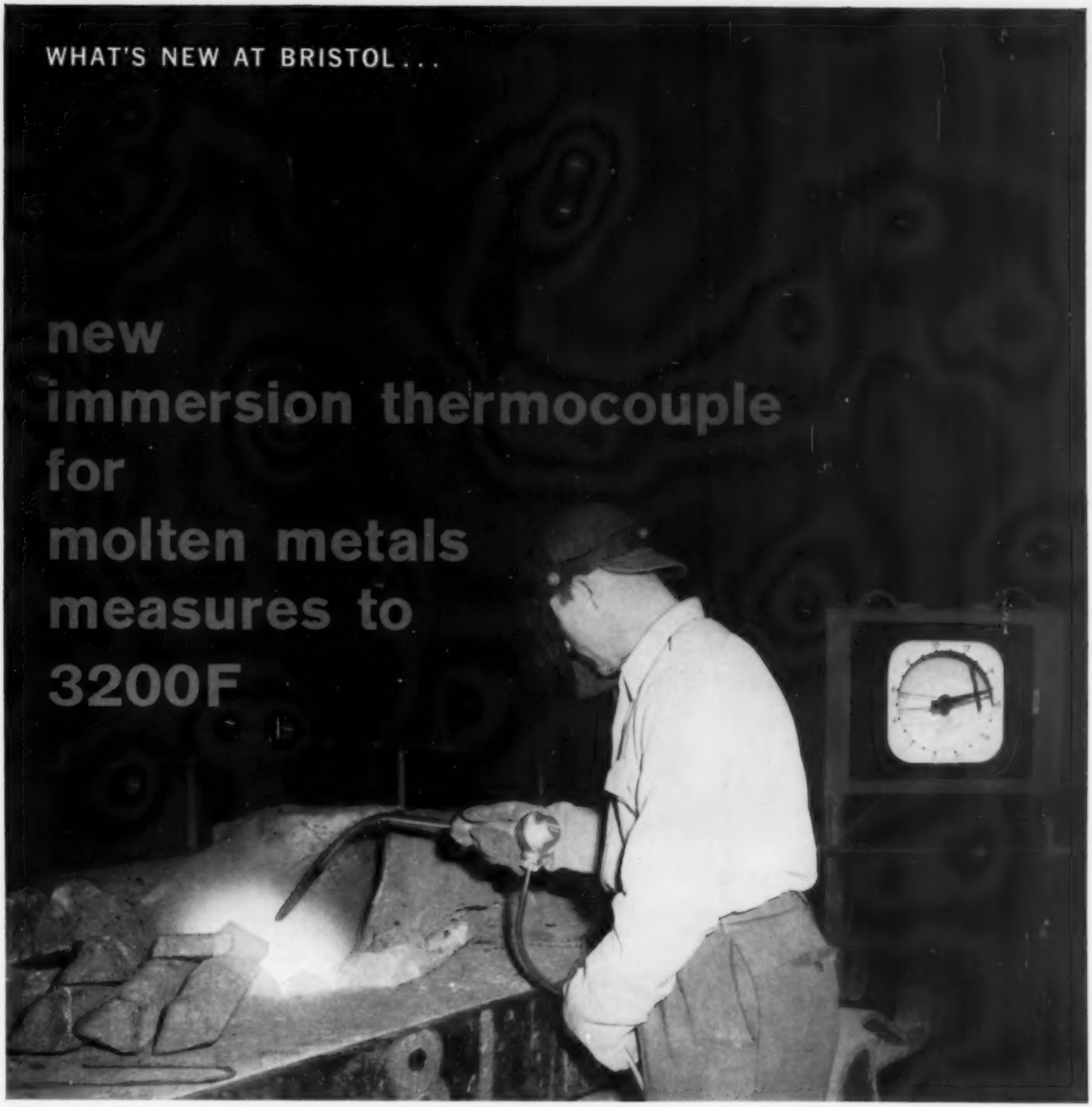
COMPANY ESTABLISHES A CANADIAN DIVISION

▲ Establishment of a Canadian Division by Wheelabrator Corp. has been announced by Otto A. Pfaff, president. The new plant is located in Scarborough (Metropolitan Toronto), Ontario.

Wheelabrator has been active in the Canadian market for the last 12 years with sales offices located in

WHAT'S NEW AT BRISTOL...

new immersion thermocouple for molten metals measures to 3200F



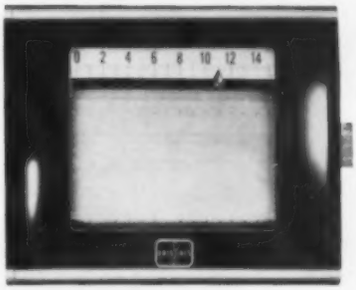
NEW BRISTOL IMMERSION THERMOCOUPLE makes direct readings in melts of ferrous or non-ferrous metals, records on round-chart Bristol Dynamaster instrument (right).

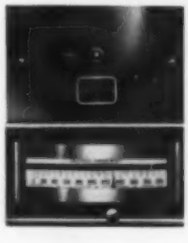
This new Bristol immersion-type thermocouple can take up to 14 dips in molten steel at 2700 F to 3200 F. With brass, aluminum and other metals of lower melting point, it has far longer life.

Simplicity, operating economy result from the new thermocouple's rugged, easily replaceable protection tubes. With reasonable care, they allow reuse of the expensive platinum sensing element.

This new Bristol immersion thermocouple is typical of recent outstanding Bristol developments in electronic pyrometry. Bristol's giant strides in automatic temperature control *are making instrument systems obsolete which were designed new only a few years ago.* Find out about these developments, before you buy any other instrument for furnace or oven. Write The Bristol Company, 123 Bristol Road, Waterbury 20, Conn. 7.23

*T. M. Reg. U. S. Pat. Off.





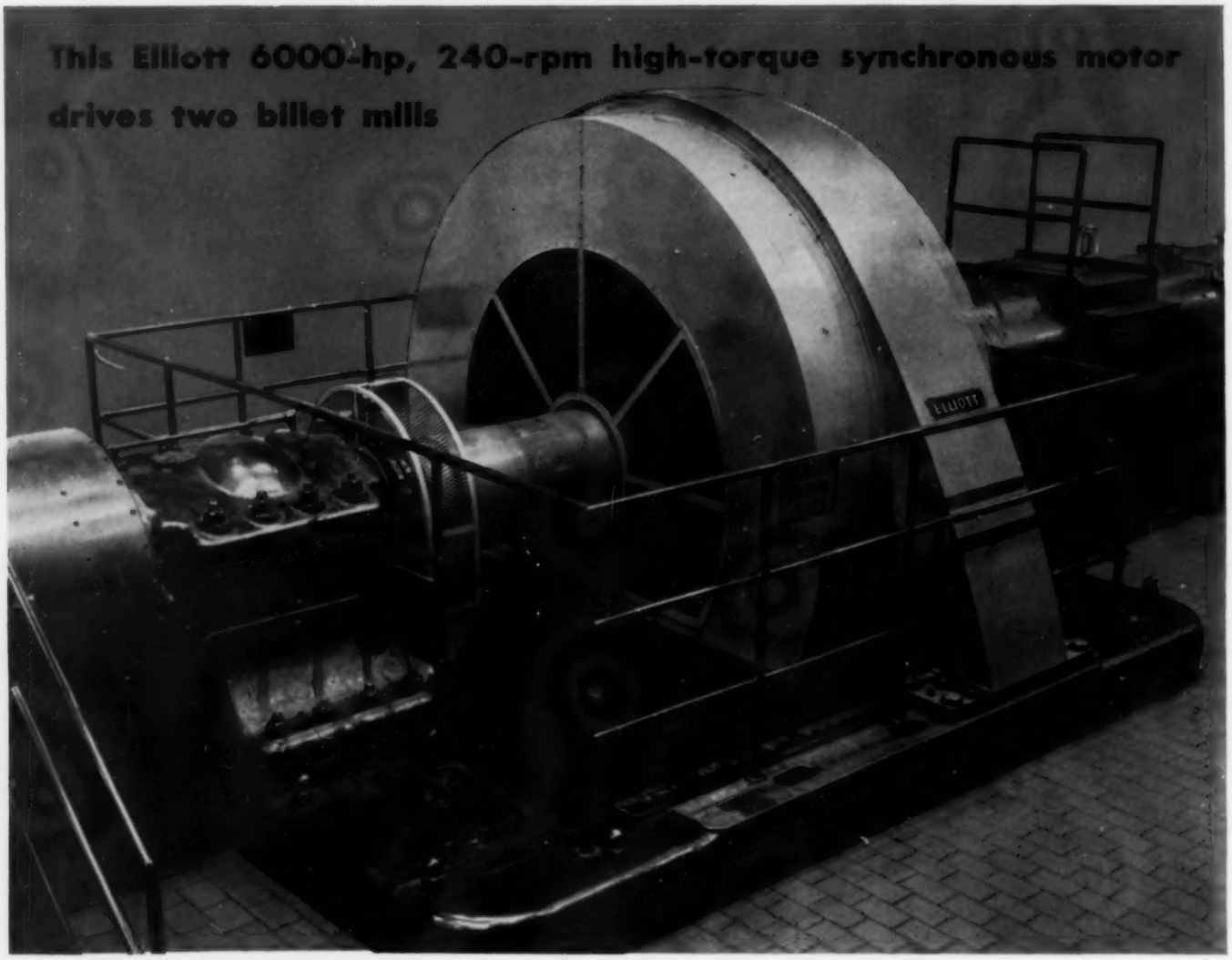
Dynamaster* Electronic Pyrometer with strip chart.

ELECTRONIC INSTRUMENTS BY BRISTOL

Free-Vane* Electronic Pyrometer Controller.

BRISTOL TRAIL-BLAZERS IN PROCESS AUTOMATION

AUTOMATIC CONTROLLING, RECORDING AND TELEMETERING INSTRUMENTS



Installed over the weekend—no lost production time

designed to fit existing bearings and base

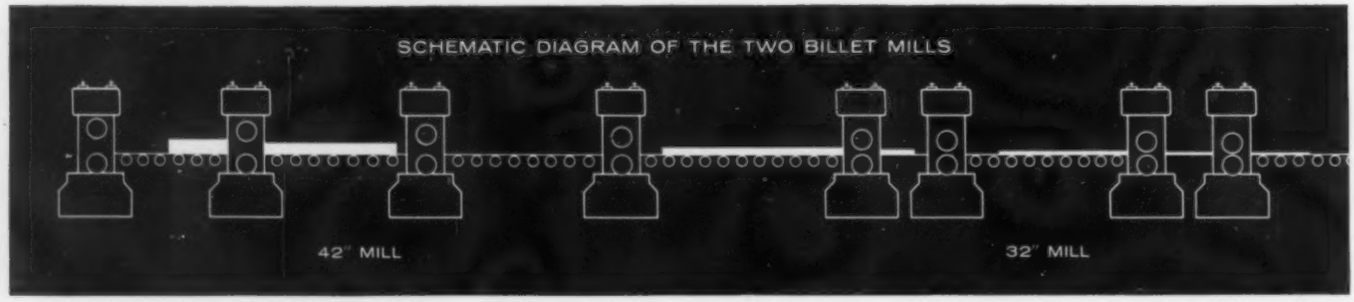
Come Monday morning, this Elliott 6000-hp high-torque synchronous motor was in operation. (On the previous Friday, power was still being furnished by an old wound-rotor motor.) The new Elliott motor drives, through gear trains, two billet mills, each containing four mill stands. The motor was engineered and built by Elliott to fit existing bearings and base, and the remarkably quick changeover reflects the excellence of Elliott engineering and workmanship.

Satisfactory experience with similar Elliott apparatus previously installed at this plant led to the selection of the Elliott motor for this billet mill drive.

ELLIOTT Company

Ridgway Division, Ridgway, Penna.

R7-24



Toronto and Montreal. Limited manufacturing of dust control equipment has been done on a sub-contracting basis.

Robert A. Campbell, Canadian district manager for Wheelabrator since 1946, is general manager of the division. The Montreal office has been expanded to include a dust and fume control engineer.

FIRMS REACH AGREEMENT ON BURNER LITIGATION

▲ Selas Corp. of America and Bloom Engineering Co., Inc., have settled their litigation concerning radiant type burners by an agreement satisfactory to both parties.

Selas Corp. and Bloom Engineering, operating under Selas patent licenses, will both continue to manufacture and furnish high thermal release radiant burners.

H. K. PORTER TO BUILD REFRACTORIES PLANT

▲ Construction of a modern tunnel kiln refractories plant at Bessemer, Ala., is part of a one million dollar program, just announced by James P. Raugh, vice president and general manager of the Refractories Division, H. K. Porter Co., Inc.

A general rehabilitation program at this plant, in addition to the new tunnel kiln and drier, will include new materials handling equipment and brick making machinery.

Swindell-Dressler Corp. has been awarded the contract. Ground breaking will begin within sixty days, and completion is scheduled for the fall of 1958, at latest. The new units will utilize present clay grinding and batching facilities at Bessemer Works.

New brick-making machinery of the most modern type, will have every modern device needed to produce burned refractory brick with the best physical properties and closer dimensional tolerances than this plant has been able to obtain in the past.

CRUCIBLE ACQUIRES NEW COAL RESERVES

▲ Crucible Steel Co. of America announced the acquisition of rights to more than 15,000 surface acres of additional coal reserves.

2-Roll SUTTON Straighteners

Manufactured under license from Sir James Farmer Norton & Co., Ltd., of Manchester, England

FOR PRECISION STRAIGHTENING, SIZING AND POLISHING OF METAL BARS FROM ⅛" to 9" DIA.

Accurate end-to-end straightening and sizing is achieved in one pass. Special roll designs make these machines ideally suited for straightening and polishing turned bar stock. Available in seven sizes for all modern metals.

Model No. 5
(Pictured)
2-Roll Sutton Straightener
for Bars from
2¼" to 7½" Dia.

Flexible—Easy to adjust for a wide range of sizes.

Dependable—Design backed by Farmer-Norton's 45 years' experience.

Ruggedly built—Sutton Universal Joints for trouble-free operation.

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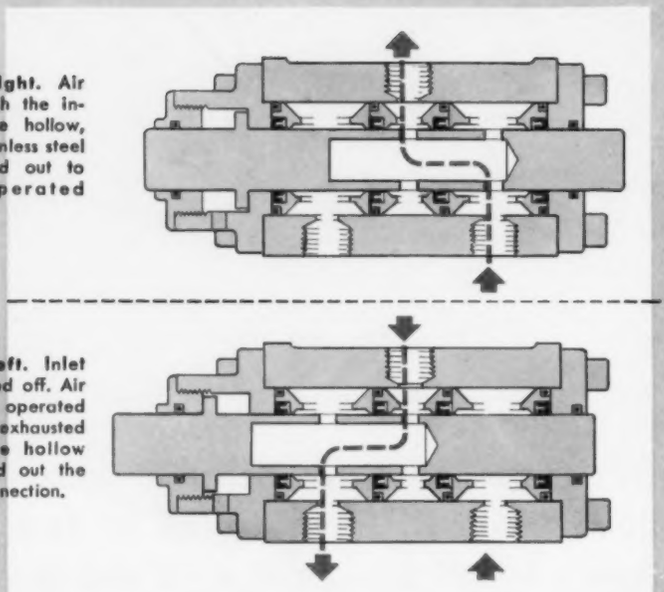
Manufacturers of Straighteners, Hydraulic Extrusion Presses, Centerless Bar Turners, Rotary Swagers, Sheet Levellers and other Finishing Machines for Modern Metals.

WHO says all control valves are pretty much alike?

This exclusive patented*

Quick-As-Wink®

construction



Plunger Right. Air flows through the inlet—and the hollow, polished stainless steel plunger—and out to the air operated device.

Plunger Left. Inlet air is blocked off. Air from the air operated device is exhausted through the hollow plunger, and out the exhaust connection.

assures users unparalleled efficiency, economy, dependability and satisfaction

Quick-As-Wink Control Valves are in a class by themselves! Our exclusive patented* valve chamber construction, that accurately positions the "O" rings and the "U" packers without mechanical pressure, meets the most exacting service requirements. No direct flow across the packings, greatly prolonging their life. No lapped joints. No metal to metal seating. Hundreds of different types and actions. Sizes from ¼" to 4". Get full details.

*U. S. Pat. No. 2,645,450

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AIR AND HYDRAULIC
Control Valves

***Mfd. by* C. B. HUNT & SON, INC., 1925 East Pershing St., Salem, Ohio**

— Engineering and Sales Representatives in the Principal Cities —

The acreage located at Hugheston, W. Va., southeast of Charleston, on the Kanawha River, is expected to yield in excess of 20 million tons of number two gas seam high volatile metallurgical coal.

At Crucible's present rate of consumption, the newly acquired tonnage along with present coal holdings makes available at least a 40-year supply for the company, more than doubling its previous coal reserves.

The new reserves will enable Crucible to extend the span of operations at its present mine at Crucible, Pa., from an estimated 18 more years to about 35 more years.

In addition to the acreage purchased on the right bank of the Kanawha, at Hugheston, Crucible has bought land stretching along the opposite bank for about 1,000 ft at Pratt, W. Va. This frontage will be used primarily as a terminal point for river barges.

B&W WILL ADD NEW ELECTRIC FURNACE

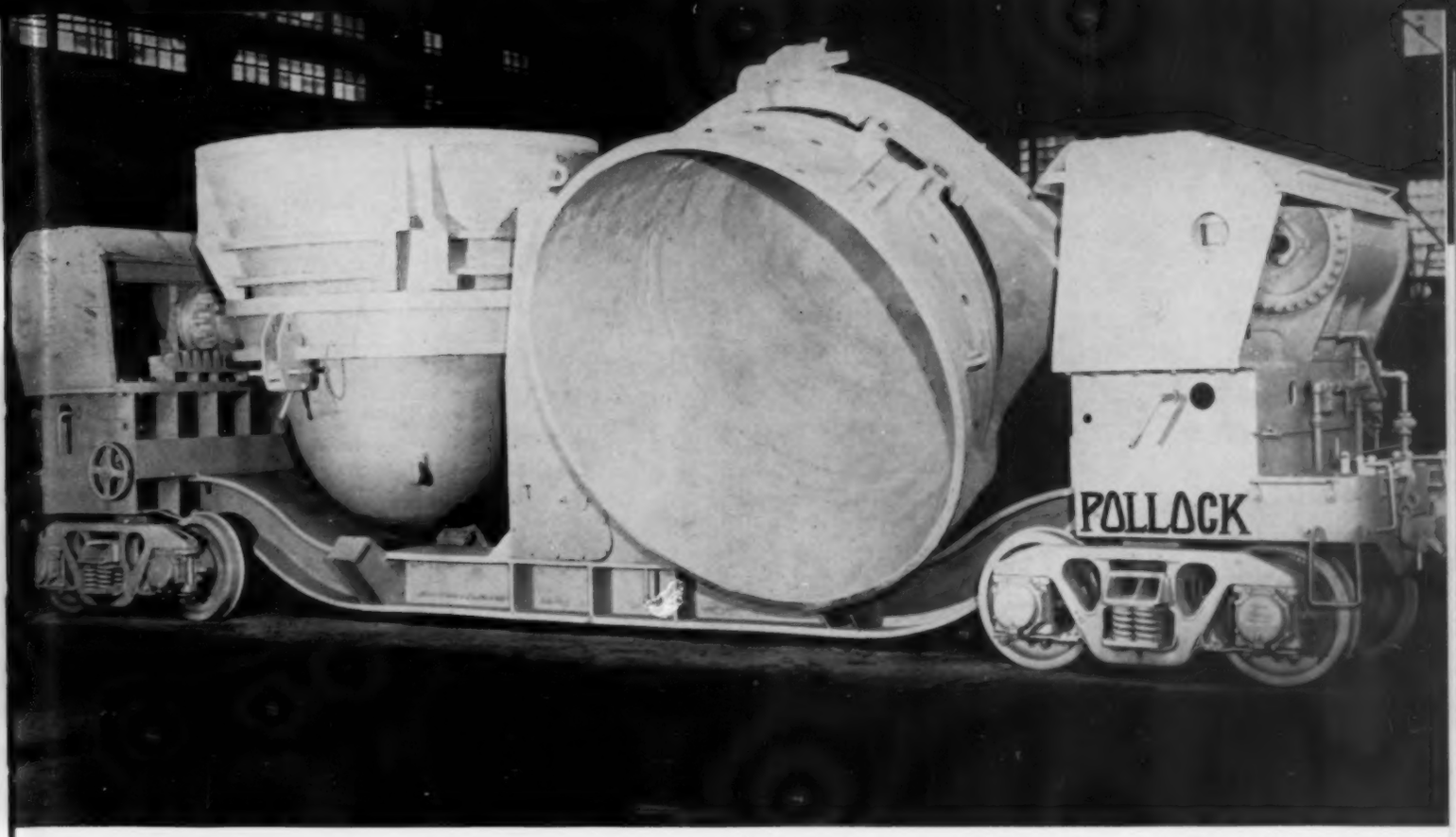
▲ The tubular products division of The Babcock & Wilcox Co. plans to expand and modernize its alloy and stainless steel making facilities with the addition of a new electric arc furnace and associated equipment, it was reported by Edward A. Livingstone, vice president in charge of the division.

The new facilities will be located near an existing extruded shapes fabrication building owned by the company, in the Koppel, Pa., area approximately four miles from the main tubular products division plant in Beaver Falls, Pa. Mr. Livingstone estimated that the facilities would cost between $12 million and $14 million.

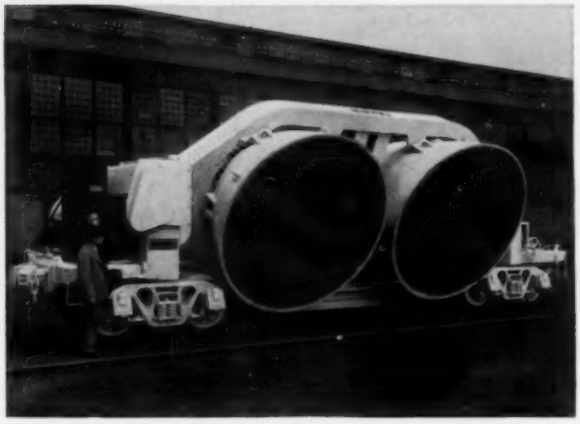
The Beaver Falls plant already has four electric arc melting furnaces, and the addition of the fifth one, Mr. Livingstone said, would give the division capacity to produce alloy and stainless steel blooms and bars of the kind and size most suitable for its tube making and extrusion operations.

Completion of the new facility has been scheduled for late 1959.

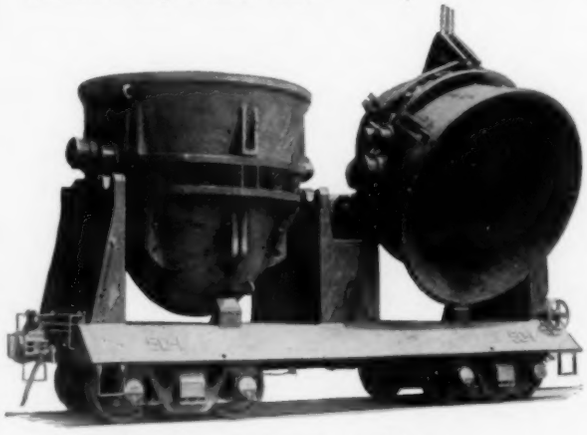
USE THE ENGINEERING MART



Double pot, air operated Pollock slag car dumps to either side. Pots dump separately or together.



Pollock double pot, electrically operated car dumps pots simultaneously to either side.



Double pot, crane dumped slag car.

ONE OF THESE
DOUBLE POT SLAG CARS
IS RIGHT FOR YOU
DO YOU KNOW WHICH IT IS?

The type and size slag car you can use most efficiently and economically depends on three things: existing facilities, clearances and the use of the car. If you process slag, an electric dump gives you slow, even distribution. If you have a railroad crane or crane at the dump you can use the crane type. If you have adequate air capacity you will want the air operated cars, because they furnish the best means of dislodging skulls. The best way to select the proper car for your use is to consult the experts at The William B. Pollock Company. Most steel producers do. Pollock has built more slag cars, of all types, than anyone else in the world.

THE WILLIAM B. POLLOCK COMPANY

Since 1863

YOUNGSTOWN, OHIO

ENGINEERS • FABRICATORS • ERECTORS • STEEL PLATE CONSTRUCTION

BLAST FURNACES • HOT METAL CARS AND LADLES • CINDER AND SLAG CARS • INGOT MOULD CARS • CHARGING BOX CARS • WELDED OPEN HEARTH LADLES

An Entirely New Concept

15,000 LB. MODEL

Greatest stability at every stage of 120 inch lift

Dotted line above shows how Automatic Elbolift's built-in retraction feature maintains maximum stability every inch of its 120" lift. Tilting action illustrated is operated by a single control lever which can tilt and/or lift load separately or simultaneously.

AUTOMATIC TRANSPORTATION COMPANY

Division of The Yale & Towne Manufacturing Company

101 West 87th Street, Chicago 20, Illinois

in Fork Lift Truck Design...

Automatic ELBOLIFT!

12,000 TO 20,000 LBS. CAPACITIES

Eliminates Mast Assembly...Weighs 6000 lbs. less than any comparable mast-type truck...is definitely superior in stability, maneuverability, and operator vision.

370% More Visibility: Picture at left dramatically illustrates the increased visibility over conventional, mast-type, heavy duty trucks. Forks completely visible when entering pallet.

Drive tires two-thirds of Elbolift's width: 32 lineal inches of the truck's 48″ overall width are in contact with the floor for the greatest load distribution and stability.

All conventional ideas of fork lift trucks were scrapped in designing this newest in the long, distinguished line of Automatic "firsts." Only in this way could Automatic engineers achieve the marked improvement in capacity, maneuverability, safety, performance and weight reduction which they had set as their goal.

The result is a truck with capacities from 12,000 to 20,000 lbs. —15,000 lb. model 48″ wide, and 105¾″ long (less forks) is actually *three tons lighter than any comparable mast-type truck.* This permits the Elbolift to operate on floors that would be unsafe for other types of comparable capacity.

Its unique design is also responsible for other advantages ...among them the following:

Exclusive New Power Steering Control—takes the guess work out of steering. *Operator always knows* the exact direction of his steer wheels by the position of the steering lever.

Shortest Inside Turning Radius—does more work, handles heavier loads in less space. Operates easily in 13′8″ right angle aisle and 78″ boxcar door with 52″ square load.

Highest Lift With Lowest Overall Height—Elbolift has 80″ overall height with a 120″ lift.

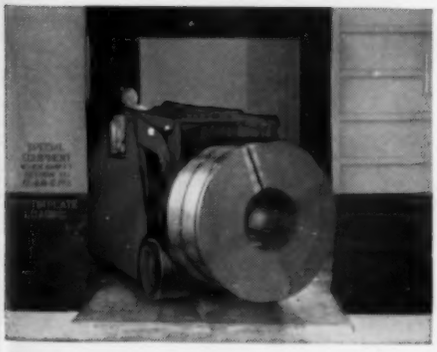
Safety—Easy on—easy off. Operator completely protected by counterweight on both sides and heel plate in the rear. Dead man control...returns speed controller to neutral and automatically applies brake when driver dismounts.

Exclusive New Inching Control—4 speeds forward and reverse with foot inching to any preset or selected speed.

Battery Accessibility—battery on rollers for quick and easy removal from either side.

But there's ever so much more than can be adequately described here. Why not get the whole story? No obligation. Just mail the coupon below...mail it today.

Maneuverability: Carrying a full load of 15,000 lbs. (52″ square), the Elbolift passes easily through any 78″ boxcar door...will right angle stack a 52″ load comfortably in a 13′8″ aisle.



Versatility: Ram attachment at left can be quickly and easily replaced by adjustable forks for handling dies, pallets, etc.

AUTOMATIC TRANSPORTATION COMPANY
47 West 87th Street, Dept. W-7, Chicago 20, Illinois

Rush me fully illustrated descriptive brochure on the revolutionary new Automatic Elbolift Trucks.

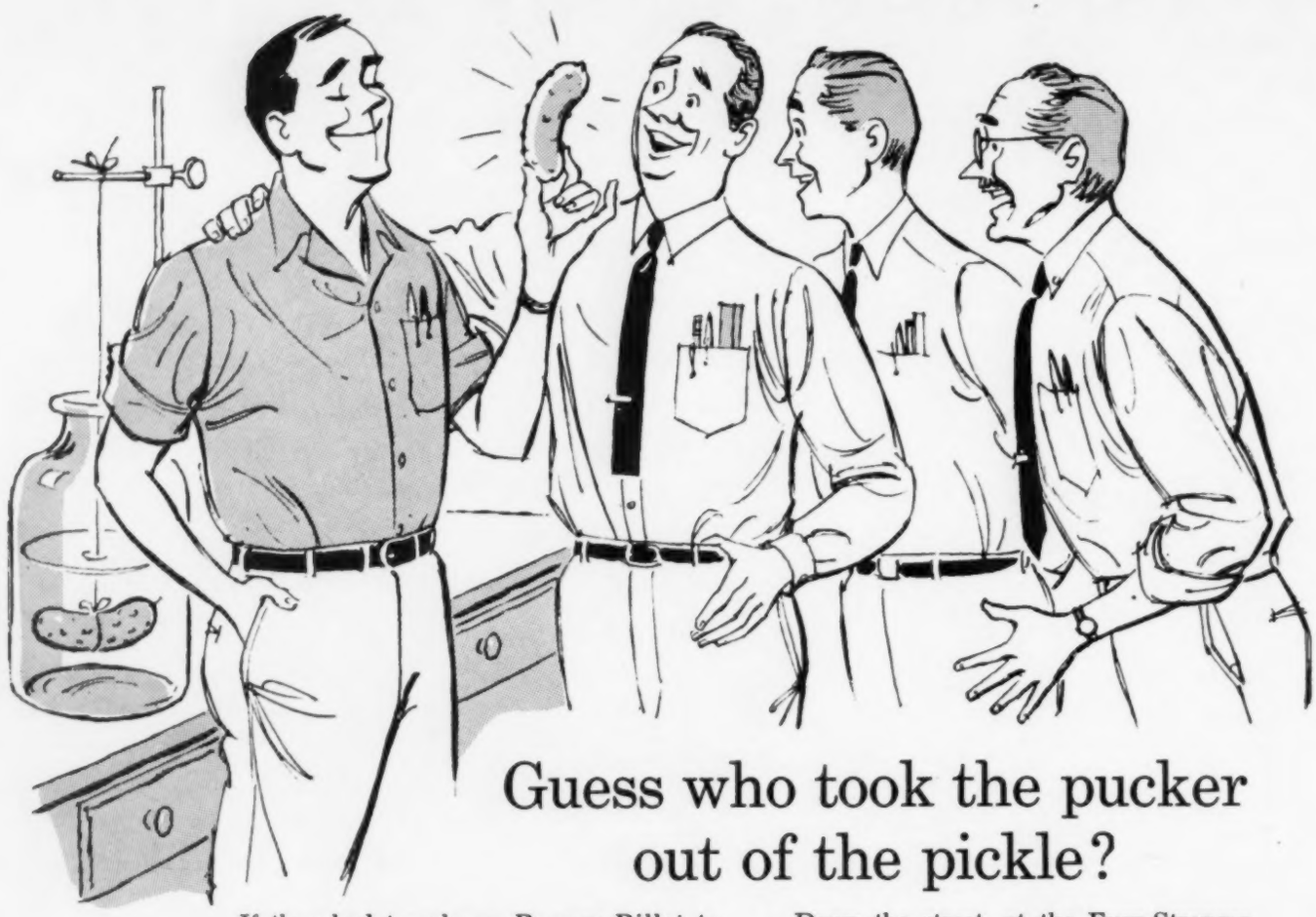
Your Name_____ Title_____

Firm Name_____

Address_____

City & Zone_____ State_____

Any similarity to a real-life company is purely intentional



Guess who took the pucker out of the pickle?

If they had to rely on Barney Billet to keep the wolf from their doors, the pickle packers would soon pound a path to the poorhouse. For the truth is Barney doesn't like pickles. To him, a cucumber is just something to stay as cool as.

So what does Barney do for a living? Why he's a major-domo of a pickling tank at O-So-Strong Steel Company!

He does a good job — pushes plenty of tonnage through the tank. Barney rates ace-high with the top ingots (you wouldn't expect *brass* in a steel mill, would you?).

They've given him the finest equipment to work with. It's *got* to be good—the pickling operation uses a 12% sulphuric-acid solution at 200°F. And that can make a meal of most metals. But not of Ampco Metal! It's a series of special, super-tough copper-base alloys specially engineered to resist wear and corrosion.

That's why O-So-Strong fabricated the strip rollers and side plates from Ampco Metal. They're practically immersed in the pickling-tank solution—but meet the acid test without puckering.

Down the street, at the Even-Stronger Steel Company, replacement costs have dipped, also, since they've used Ampco Metal in pickling hooks, crates, baskets, yokes, and chains.

Ampco Metal has shown its mettle in other ways; for example, in rolling-mill applications where resistance to wear and shock loads is important — in screw-down nuts, screw-down worm wheels, slippers, breaker blocks, and other critical parts.

Though pickling may not have *you* in a pickle, chances are this story still applies to you. For nothing solves most wear, corrosion, erosion, abrasion, or cavitation problems like Ampco Metal. You can get it in any form — sand-cast, centrifugally-cast, shell-molded, precision-cast, forged, fabricated, extruded, sheet, or plate.

Your Ampco field engineer is the one to give you all the facts. Call him in. And write for Bulletin 33. *Ampco Metal, Inc., Dept. IS-11, Milwaukee 46, Wisconsin.*

AMPCO®

(West Coast Plant: Burbank, California)

AMPCO® METAL

The metal without an equal

G-8

CARPENTER STEEL OPENS NEW CHICAGO WAREHOUSE

▲ The Carpenter Steel Co., has opened a new and larger mill branch warehouse and office in Chicago to meet the increased demand in that area for specialty tool, stainless and alloy steels. It will be midwestern headquarters for both the main company and its Alloy Tube Division.

The new installation replaces a former warehouse operated by the firm in Chicago for the past 30 years. It gives the company better facilities and more space to carry a full line of warehouse stock. A full sales and technical staff is assigned to render engineering application service on all of the steels handled.

Carpenter's Alloy Tube Division will use the new offices as the base of operations for a sales territory embracing 18 midwestern states.

WELDING FIRM ACQUIRES NEW METALWORKING LINE

▲ The Taylor-Winfield Corp. has purchased the exclusive lines of metal-forming and work-handling machinery formerly built by the Struthers-Wells Corp., Titusville, Pa.

This acquisition permits Taylor-Winfield to design and build coordinated production lines to process coil or strip through to the finish welded product. The Warren firm will also manufacture individual metal-forming machines and will provide repair, redesign, and replacement service for metal-forming and work-handling equipment previously manufactured by Struthers-Wells.

The purchase gives Taylor-Winfield facilities to manufacture tangent benders, folding machines, punching and notching machines, roller table and tumble die bending machines, brake presses, special sheet metal forming dies, sheet destackers and feeding machines, special section and pipe benders and similar custom-designed equipment.

Key management, engineering and manufacturing personnel of Struthers-Wells, including Edward P. Schneider, former Machinery Division manager, have joined Taylor-Winfield to help integrate the new activity into the present organization.

T. S. Long, Taylor-Winfield vice president and general manager, described the acquisition as a move to improve service to sheet metal fabricators in two ways.

"Formerly," Mr. Long said, "fabricators could install mass-production lines only by ordering various equipments from several suppliers. By manufacturing a complete metal fabricating line, Taylor-Winfield will eliminate duplicate liaison and save customer engineering time. Also, one manufacturer will now be responsible for the entire line."

He added that many users of resistance welders require metal-forming and work-handling equipment installed on welders. He said Taylor-Winfield will now be able to match this associated equipment more closely than was previously possible.

Struthers-Wells officials report that the purchase of its metal-forming and work-handling lines will not affect their company's other activities. These include the manufacture of rough and machined heavy forgings, boilers, welded equipment and processing equipment for the chemical and petroleum industries.

WORLD'S LARGEST
OPEN HEARTH FURNACE
Designed and Built By Loftus

Late in 1956, the largest open hearth furnace in the world was tapped at Weirton Steel Company, Division of National Steel Corp., Weirton, W. Va.

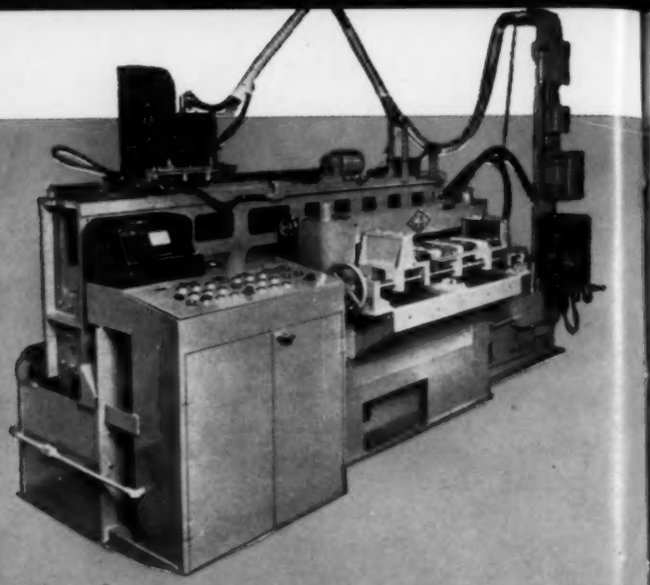
Designed and built by Loftus Engineering Corp., this huge furnace has a rated capacity of 600 tons, is approximately 111 feet long by 30 feet wide, and construction was completed in less than a year. Operation is simple since the furnace is equipped with full automatic control.

If you are planning expansion or modernization of your heating facilities (ferrous or non-ferrous), we would like to demonstrate how Loftus' long experience in furnace design and construction can benefit you. Write us today. There is no obligation.

From first heat to heat treat, look to LOFTUS
Engineering Corporation
1 Gateway Center, Pittsburgh, Pa.
140 S. Dearborn St., Chicago, Ill.

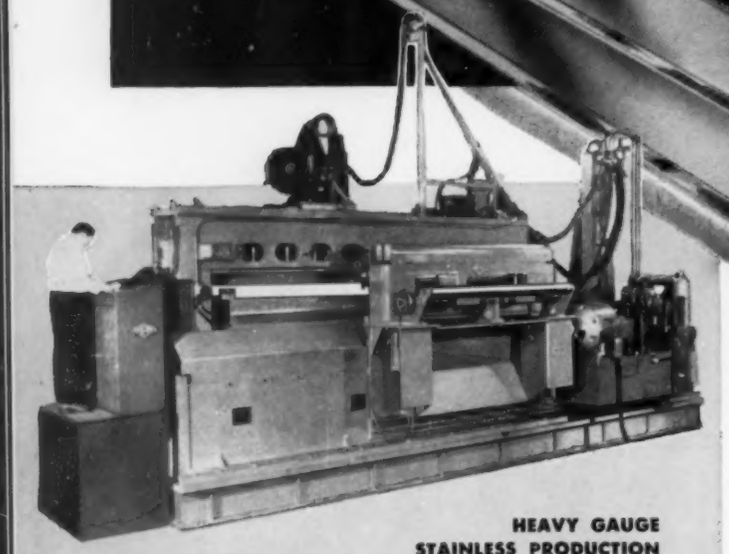
57.8.3 A

THE NEW MPM Shear Welder



CONTINUOUS SILICON SHEET PRODUCTION

Shearwelder for coil build up line for 42" wide Silicon Steel from .015" to .030" thick.



HEAVY GAUGE STAINLESS PRODUCTION

Shearwelder for butt welding 60" wide x .250" thick Stainless Steel.

.....more automation for even faster Steel Production!

● Metal Processing Machine Company's new Shearwelders are outstanding because of their advanced design incorporating automatically sequenced operations.

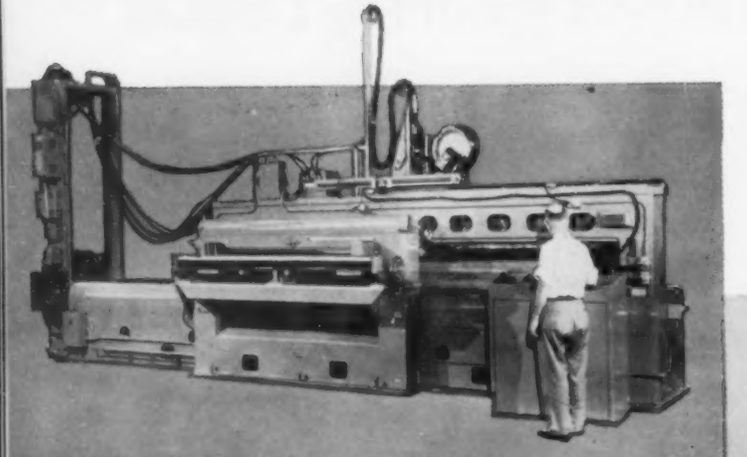
Shearing and welding are performed at the same station with positive clamping right at the work area, thereby insuring perfectly aligned butt welds.

"M.P.M." welds are **extremely ductile,** permitting subsequent rolling, forming, or blanking operations. Weld joints are smooth and require **no trimming.**

Rugged construction is insurance for minimum maintenance and compact design saves floor space.

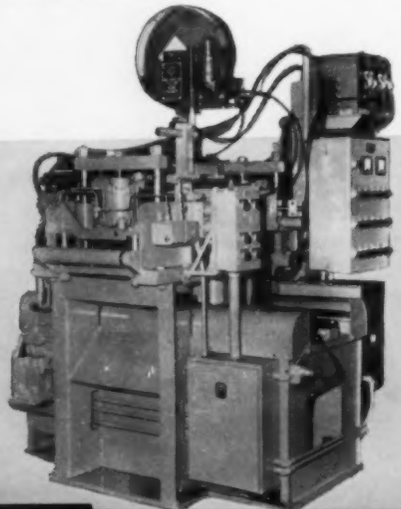
THE METAL PROCESSING MACHINE CO.

SUBSIDIARY OF McKAY MACHINE CO.
YOUNGSTOWN, OHIO



MAJOR COIL BUILD UP

Shearwelder for Carbon Steel coil build up line for .015" to .060" thick x 72" maximum width.



MPM

CONTINUOUS TUBE MILL PRODUCTION

Shearwelder used with strip looping device for splicing coil to coil to permit continuous production of tube mill.

10065

Publication Service...

You Can Obtain . . .

. . . any of the bulletins reviewed in the Publication Service of the IRON AND STEEL ENGINEER without obligation or cost. Simply circle the desired item numbers on one of the prepaid postal cards and mail. The requests will be forwarded to the manufacturers involved who will send the bulletins to you.

Note: Post cards expire three months after publication date.

(1) Lubricants

The Brooks Oil Co. now has available a 16-page brochure which describes a wide range of tough lubrication jobs of industry, and explains the use of Brooks E. P. products in solving severe applications. Products are detailed as to type and application. Also illustrated and described are the modern facilities and laboratories. The continuing research program carried on throughout the 80-year history of the company is also described in detail.

(2) Safety Clothing

Product items of a new complete line of aluminized asbestos safety clothing are described in a bulletin published by Mine Safety Appliances Co. Designed for the added comfort and protection of workers in "hot spot" job assignments, the new flexible, light weight clothing is suggested for wear in plant operations involving working white hot ingots, coking, slagging, furnace repair and similar high heat occupations. Contained in the bulletin is a review of the protective properties of the safety clothing—said to reflect over 90 per cent of all radiant heat. A keyed chart of laboratory controlled test results indicates the high heat-resisting efficiency of the new clothing in contrast with the performance of other commonly used protective materials (1301-7).

(3) Moisture Control System

Foxboro Co. has published a data sheet and bulletin explaining how to maintain dew point in blast air. The bulletin describes dew point recorders and controllers; graphs are included showing operating range characteristics, as well as different dew point recorders. The data sheet includes a chart of the moisture control system for air to blast furnace, a typical chart record, and a control cabinet.

(4) Steel Mill Control

Westinghouse Electric Corp. has published a booklet describing their new control system, "Prodac." The booklet explains what this new steel mill control is, what it can do, and its future potential. The first installation of the system, on a reversing roughing mill, is used to illustrate the system's application.

(5) Cast Iron Machining

A comprehensive bulletin on machining and abrasive finishing gray and nodular iron castings is available from The Hamilton Foundry & Machine Co. Divided into two articles, the first article covers such subjects as: machining properties of cast iron, cutting tools and machine tool requirements, the economics of cutting speeds versus tool wear, tool change and repair, and idle machine time. The second article contains valuable performance data on various types of grinders.

(6) Cut-in Valve

Golden-Anderson Valve Specialty Co. has issued a four-page bulletin describing their cushioned emergency cut-in valve. This valve automatically opens to the emergency water supply when the mill's normal water supply is interrupted, either from outage of electrical power or mechanical failure causing pump shutdown. Schematic drawings of installation, parts lists and dimensions are included with other pertinent technical data (Bulletin W-14).

(7) Delivery System for Bulk Gases

A 16-page pamphlet which discusses the bulk delivery method of handling industrial gases in large quantities is now available from Air Reduction Sales Co. Entitled "Bulk Gas Delivery System," the catalog illustrates the several types of delivery units and explains the advantages of each. Diagrams show various plans for trailer unit parking and indicate the yard space required by each. Typical installations are pictured and unit specifications are tabulated for easy reference. Related information on control equipment, measurement of gas consumption, and distribution pipelines is also included (ADC 663A).

(8) Coil Handling System

The Lee Wilson Engineering Co., Inc., has announced a new, improved, complete and automatic handling system for rod and wire coils. The system enables one man to quickly and efficiently prepare the coils for annealing and handle the coils after annealing. It includes all the equipment necessary from special crane tongs to improved unitized spider. The entire system is thoroughly discussed and illustrated in a new brochure (Bulletin 3-57-W).

(9) Industrial Installations

A brochure describing and illustrating its services has just been published by Commercial Contracting Corp. The book includes sections devoted to press erecting, rolling mill installations, machinery installations and moving, foundry and overhead crane installations and mothballing. The brochure also refers to specific programs that have been carried out.

(10) Flexible Cushion Coupling

A new bulletin describes a completely different flexible cushion coupling introduced by Dodge

Manufacturing Corp. A full page of general information explains how the coupling, by means of rubber tire element, accommodates angular misalignment, parallel misalignment and end float, singly or in any combination, besides cushioning shock loads and diminishing torsional vibration. Full view and cutaway photographs are included along with drawings to illustrate construction and installation features of new product, including the Taper-Lock method of mounting on shafts. Several pages are devoted to tables with engineering data to facilitate selection of couplings for a multitude of applications (A-669).

(11) Straighteners

The Waterbury Farrel Foundry & Machine Co. pictures and describes their line of straighteners for flattening ferrous and nonferrous coiled strip or sheet in a new 12-page catalog. The machines covered are divided into four types: (1) roll feed straighteners with direct pinion drive, (2) spindle driven roll straighteners, (3) back tension units used in rolling mill operations and (4) special, custom-engineered straightening units. Covered in the section on roll feed straighteners are rolls and roll adjustments, automatic slack control, feed and roll drive and permanent or portable models. Units are pictured with and without optional coil boxes. A specification table for standard straighteners is included. Under roll straighteners text and illustrations present the two main styles: (1) for narrow to medium strip width and (2) for wide stock requiring central supporting rolls. A variety of back tension units and special straighteners engineered for specific applications are shown. A questionnaire inserted in the back of the booklet facilitates specific customer inquiries (820-T-5).

(12) Drum Cleaning

Fast, efficient removal of dirt, rust, paint and other foreign materials from drum exteriors, interiors and lids by Rotoblasting is described in a new four-page specification bulletin released by the Pangborn Corp. The bulletin explains how the automatic drum cleaning machine thoroughly cleans covers and drums inside and out with a single Rotoblast wheel. Automatic loading techniques of 30–55 gallon drums, production cost studies, operator safeguards, engineering specifications and diagrams that show how drums are cleaned inside and out, are also given. Specifications include plan and front views plus information giving space required, over-all height, shipping weight, abrasive requirements, and other engineering data (Bulletin 220).

(13) Gas Generators

A brochure describing the line of gas generators manufactured by The A. A. Straub Co. has been announced. The four-page folder includes description of the three basic types of gas generators made by the company—Endothermic, Exothermic and Nitrogen, as well as a helpful table on the application of gas generators in eight major processing industries. Illustrations of alumina regenerative dryers and refrigerated gas coolers made by Straub are also included.

(14) Batteries—From Theory to Maintenance

The complete scope of motive-power battery maintenance and repair is described in a revised edition of the "Battery Users Manual," just issued by the Industrial Division of Gould-National Batteries, Inc. Developed as a result of in-plant training courses conducted by Gould service engineers, the 44-page book has been specifically designed to enable plant engineers, superintendents and foremen to conduct an organized battery training course in their own plant. Encompassing every phase of battery maintenance, repair and selection this reference manual includes over 60 photographs, diagrams and tables to review battery theory and construction, demonstrate proper battery selection, illustrate charging method and equipment, demonstrate battery testing and techniques, and to present correct battery room layout (GB-1599A).

(15) Magnetic Motor Starters

A 20-page publication available from General Electric Co. contains comprehensive data on new NEMA Size 0 and 1 magnetic motor starters for such applications as machine tools, pumps, hoists, blowers, saws, fans, mixers, compressors, and motor control center. The bulletin shows how product's design contributes to fast installation, simplified wiring, easy inspection and maintenance, long life, quiet and dependable operation, and maximum flexibility. It also describes all available forms and enclosures. It points out features of nine different field modification kits. Ordering information for contactor and across-the-line reversing, non-reversing, combination and multispeed starter forms as well as on modification kits is included. Dimensions are given on open and enclosed forms (GEA-6611).

(16) Pipe and Tube Straightening

A 24-page bulletin, "How to Straighten Pipe and Tube," has been released by the E. W. Bliss Co., Mackintosh-Hemphill Division. It describes straightening problems and methods, model specifications and dimensions, and gives operating instructions for the line of rotary straighteners, all of which now feature the improved new 3-post construction method. Another section contains advice on building entry and delivery tables, and information on supplemental uses for rotary straighteners. Fully illustrated, the bulletin also gives case histories on the use of rotary tube straighteners by various companies (Bulletin 55-A).

(17) Pallet Transporter

The Automatic Transportation Co. announces a four-page brochure giving complete specifications and drawings of the low lift pallet Transporter, walkie-type electric-driven industrial truck, Model WPY 4 and 6. Trucks described have lifting capacities of 4000 and 6000 lb, are only 29¼ in. long plus load, and yet have a standard 15½-in. battery compartment. This compact design reduces aisle space requirements and improves maneuverability. A feature of these two models is the Pallet-Chek, a set of spring-loaded pawls that holds the pallet firmly while the forks enter, thus saving time and eliminating, in most cases, the need for costly chamfering of end boards in double-faced pallets.

(18) Geared Flexible Couplings

A book describing Link-Belt Co.'s complete line of improved geared flexible couplings has just been released. The 12-page publication, details pertinent application and selection data for cou-

plings with maximum bores ranging up to seven in. and ratings from 2½ to 572 hp per 100 rpm. The book details four basic applications, each available in ten standard sizes. They are: Type SG—standard coupling for close-coupled direct-driven industrial equipment. Type SGE—spacer coupling to connect shafts that are separated by relatively short distances. Design permits removal of entire coupling without disturbing mounting or alignment of connected machinery. Type SGM—mill motor coupling for use with mill motors, compressors, etc., where one or both of the shafts is tapered. Type SGS—single engagement coupling, customarily used in pairs with a floating shaft for connection of remote shafts. Packaged components in bore sizes up to 2¾ in. permit "off the shelf" delivery from Link-Belt distributors and factory branch stores (Book 2775).

(19) Transformers

Delta-Star Electric Division, H. K. Porter Co., Inc., has published a 16-page catalog for their new line of single phase, 15,000 volts and below, 167 Kva and below Type OS distribution transformers. The book clearly describes and illustrates every detail of these transformers from core to cover, even including final inspection and crating. It also explains and pictures the modern production and testing facilities for manufacturing these all-new transformers. Complete tables and drawings give high and low voltages, taps, Kva, catalog numbers, classes, over-all dimensions and approximate weights.

(20) Package Unit Substations

An eight-page bulletin covering package unit substations has been issued by the Square D Co. The bulletin explains the advantages which substations offer when used in modern electrical systems and shows a complete line of Square D equipment which has been designed to meet the needs imposed by modern systems. Both high voltage and low voltage components are covered (Bulletin SD-61).

(21) Induction Heater

Features of Allis-Chalmers Manufacturing Co.'s high frequency motor-generator induction heating equipment particularly applicable for efficient, low cost brazing, annealing, deep hardening, forging, and melting are covered in a new bulletin released by the company. Included is a description of 960, 3000 and 10,000-cycle high-frequency motor-generator units available in sizes from 30 to 1250 kw (12B8513).

(22) Pocket Welding Guide

"How to Get Better Welds" is a completely revised edition of Welders' Vest Pocket Guide containing 60 pages of useful arc welding information. The booklet, now available from Hobart Brothers Co., gives information on metals and electrodes, four essentials of proper welding procedures, the fillet weld, types of joints, typical welding positions, welding symbols, standard steel shapes available for welding, causes of common welding troubles and what to do about them, definition of welding terms, weight of weld metal deposited, spark tests by grinding, factors to consider in selecting electrodes, types of electrodes, how to select welding electrodes to weld ferrous metals, how to select electrodes to weld corrosion-resisting steels, electrode identification key, explanation of AWS Classification Numbers and comparative index of welding electrodes (EW-201).

(23) Starters

The latest design features in their front access, high voltage starters (Type H) for 2300 to 5000-volt motors which provide maximum accessibility, protection, performance and space economy are given in a new bulletin released by Allis-Chalmers Manufacturing Co. The bulletin points out how the starter's roll-out type air-break contactor (Type 256A) makes inspection and routine maintenance of the unit easy. The manner in which the starter provides complete protection in eight ways for men, motors and machines is diagrammed in the bulletin, and the way in which components are separately tested to give maximum performance is also related.

(24) Industrial Hydraulic Equipment

Available from Benjamin Lassman & Son, is a new brochure illustrating and describing their industrial hydraulic equipment for the 1000–3000-psi pressure range and higher and for heavy duty continuous service. Valves, cylinders, pump units, presses and special control systems are included (BL-757)

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First Class Permit No. 1963, Sec. 34.9, P.L. & R. Pittsburgh, Pa.

IRON & STEEL ENGINEER
1010 EMPIRE BUILDING
PITTSBURGH 22, PA.

IRON & STEEL ENGINEER

Send The *free* Booklets Circled Below:

*NOVEMBER, 1957

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PUBLICATIONS CURRENTLY OFFERED by Iron and Steel Engineer Advertisers

ITEM	COMPANY	BULLETIN	DESCRIPTION
50	ADALET MANUFACTURING CO., THE	CATALOG SECTION E	Vapor-tight lighting
51	AMPCO METAL, INC.	BULLETIN 33	Metals
52	ASKANIA REGULATOR CO.	BULLETIN 33.1	Edge position controls
53	ATLAS CAR & MFG. CO.	BULLETIN 1283	Transfer cars
54	AUTOMATIC TRANSPORTATION CO.		Elbolift trucks
55	BAILEY CO., WILLIAM M.		Clay guns
56	BLISS CO., E. W.	CATALOG 40-A	Rolling mills
57	CAMPBELL MACHINE DIVISION, AMERICAN CHAIN & CABLE CO.	BULLETIN DH-460-B	Abrasive cutting machines
58	CHEMICAL CONSTRUCTION CORP.		Washers
59	DELAVAL STEAM TURBINE CO.	BULLETIN 1004	Centrifugal pumps
60	DRAVO CORP.	BULLETIN NO. 1350-33	Cab conditioners
61	EDDYSTONE, DIV., BALDWIN-LIMA-HAMILTON CORP.	BULLETIN 6002	Foundry bulletin
62	ELECTRIC CONTROLLER & MFG. CO., THE	BULLETIN 6550	Punched card and slider-contact panel systems of automatic rolling
63	ELECTRIC CONTROLLER & MFG. CO., THE	BULLETIN 1300 SB	All-welded magnets
64	ELECTRIC MACHINERY MFG. CO.	E-M FOTO-FACTS NO. 16	Motor applications in steel mills
65	EUCLID ELECTRIC & MFG. CO., THE	BULLETIN 5005	Contactors
66	FARVAL CORP., THE	BULLETIN 26-S	Centralized lubrication
67	FURNACE ENGINEERS, INC.		Furnace equipment
68	GENERAL ELECTRIC CO.	GEA-6706	Mill-duty master switches
69	HARNISCHFEGER CORP.		How to evaluate crane bids
70	HERR EQUIPMENT CORP., THE	BULLETIN NO. 561	Processing and handling equipment
71	HUNT AND SON, INC., C. B.	BULLETIN NO. 571	Air and hydraulic control valves
72	KOPPERS CO., INC. FAST'S COUPLINGS		Couplings
73	KOPPERS CO., INC. ENGINEERING AND CONSTRUCTION DIV.		Chemical engineering services
74	LARCO, INC.	BULLETIN AC-573	Crane cab and pulpit air conditioners
75	LINK-BELT CO.	BOOK 2447	Gearmotors
76	LINK-BELT CO.	BOOK 2416	Belt idlers
77	LUBRIPLATE DIV. FISKE BROTHERS REFINING CO.		Lubricants
78	MASTER BUILDERS CO., THE		Grouting guide
79	MURRAY MANUFACTURING CO., D. J.	CATALOG NO. 956	Unit heaters
80	PANGBORN CORP.	BULLETIN 608	Descaling machines
81	PENNSYLVANIA ENGINEERING CORP.		Equipment designed and fabricated by PEC
82	RADIO CORP. OF AMERICA		Industrial television
83	RELIANCE ELECTRIC AND ENGINEERING CO.	BULLETIN L-2505	Drives
84	SPRAYING SYSTEMS CO.	DATA SHEET 6120	Descaling nozzles
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86	UNITED STATES STEEL CORP. INDUSTRIAL CARS		Custom designed cars
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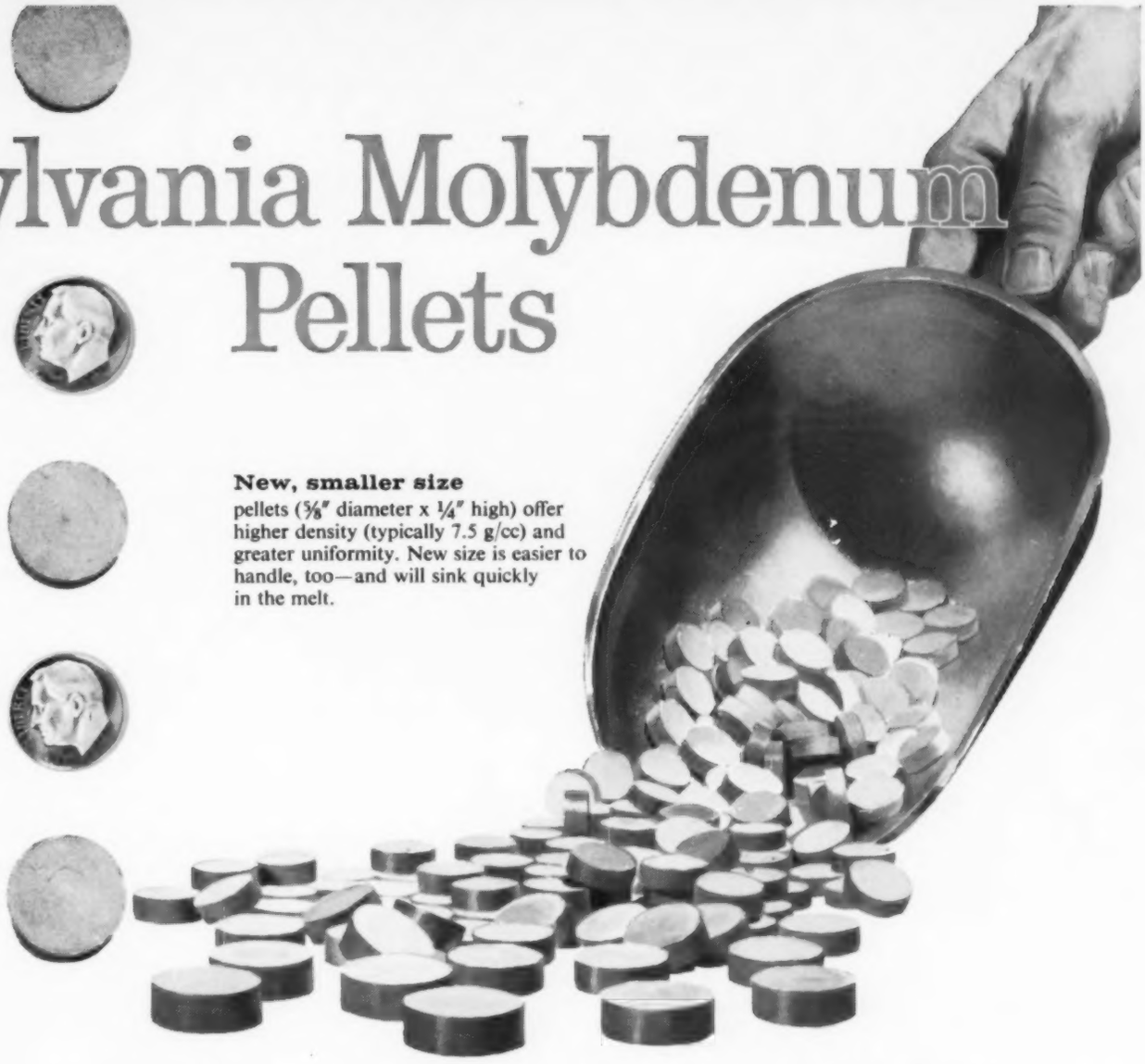
Sylvania Molybdenum Pellets



New, smaller size
pellets (⅜″ diameter x ¼″ high) offer higher density (typically 7.5 g/cc) and greater uniformity. New size is easier to handle, too—and will sink quickly in the melt.

—the new form manufactured to specified purity and composition

Sylvania Molybdenum Pellets are designed and manufactured specifically for use in vacuum melting. They provide a readily available source of the best purity molybdenum (typical 99.85%) available on the market. Detrimental impurities are at an extremely low level. This consistent high purity simplifies the calculation of additions to each melt as the usual variations of purity and gas content are eliminated.

By maintaining a high density, the gas content of the pellets is kept well below that acceptable for vacuum melting. In addition, the compact uniform size of the pellets facilitates weighing and charging to the melt.

When you use Sylvania Molybdenum Pellets, you benefit in other ways, too. Their continuous availability means you can plan your production schedules on a long-range basis. Further, their pricing stability permits you to price your own product without having to worry about fluctuating raw materials costs.

Call your Sylvania representative or write for details.

SYLVANIA ELECTRIC PRODUCTS INC.
Chemical and Metallurgical Division
Towanda, Pennsylvania

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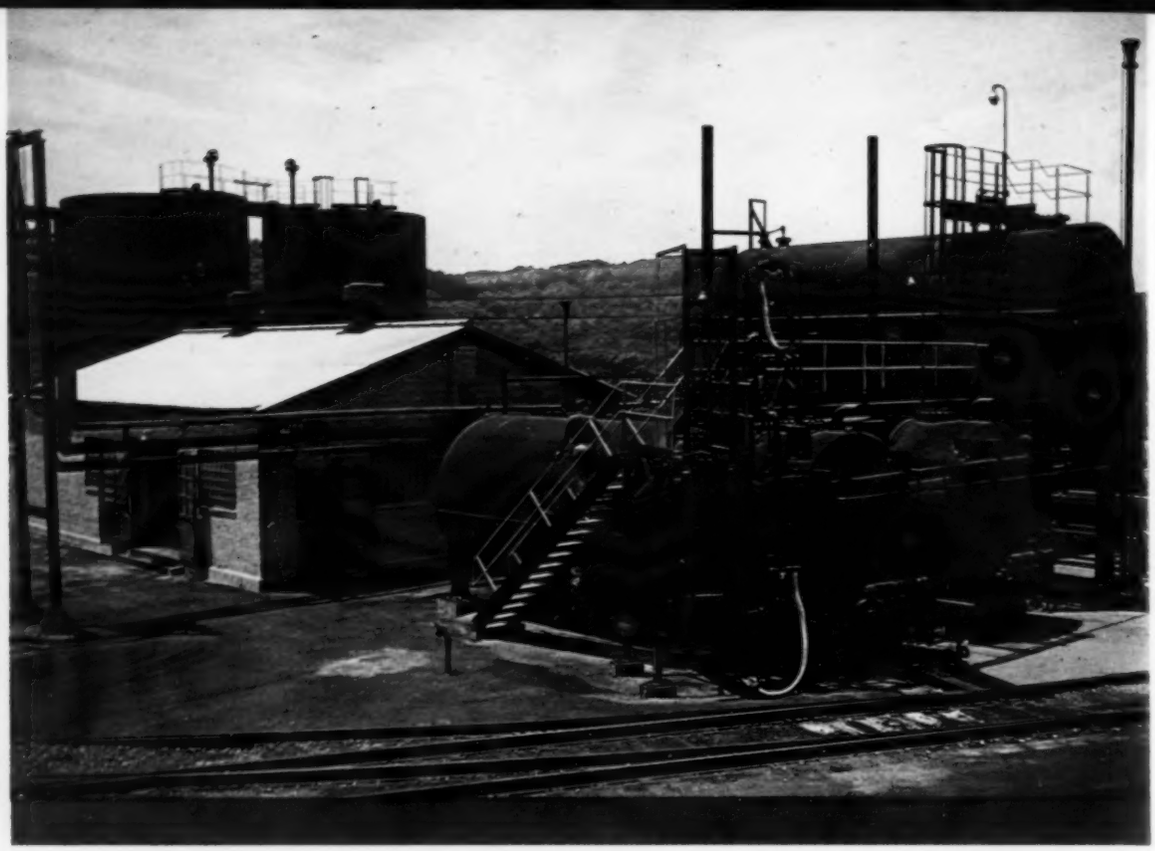
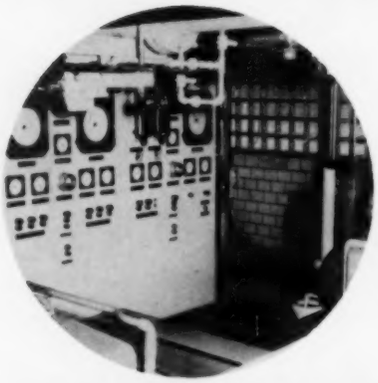
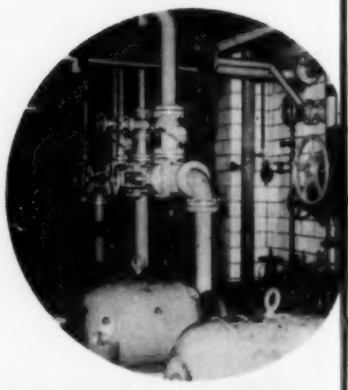
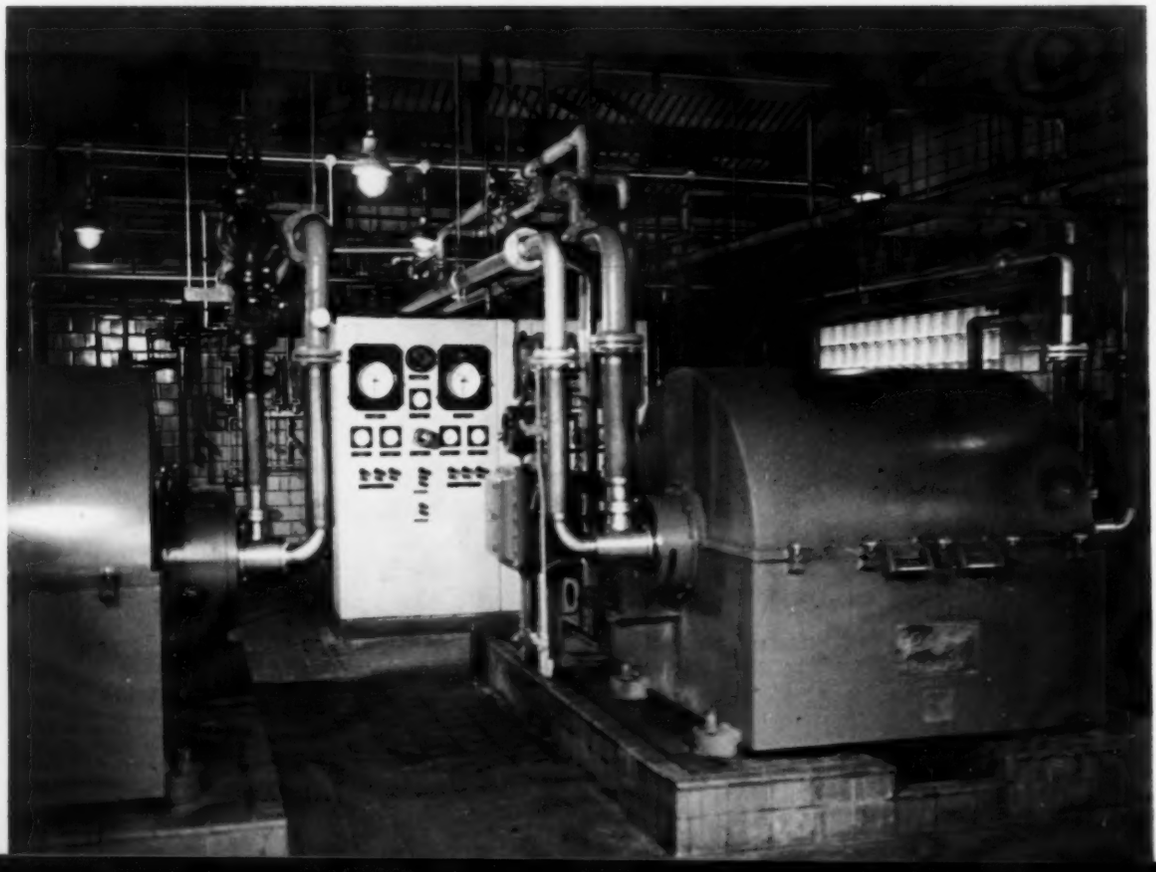
LIGHTING • RADIO • ELECTRONICS • TELEVISION • ATOMIC ENERGY

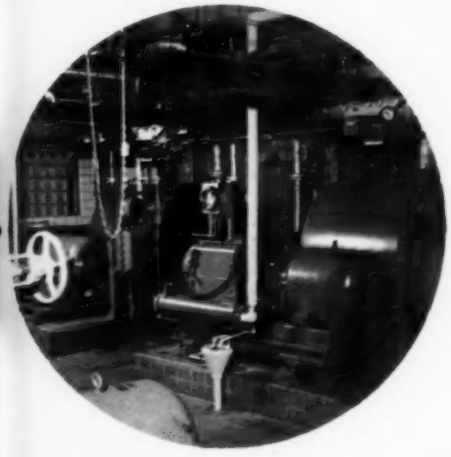








WILPUTTE'S SUPERIOR PHENOL REMOVAL



Wilputte's new continuous phenol removal process using Podbielniak extractors is now operating at the Weirton Steel Company, a Division of the National Steel Corporation.

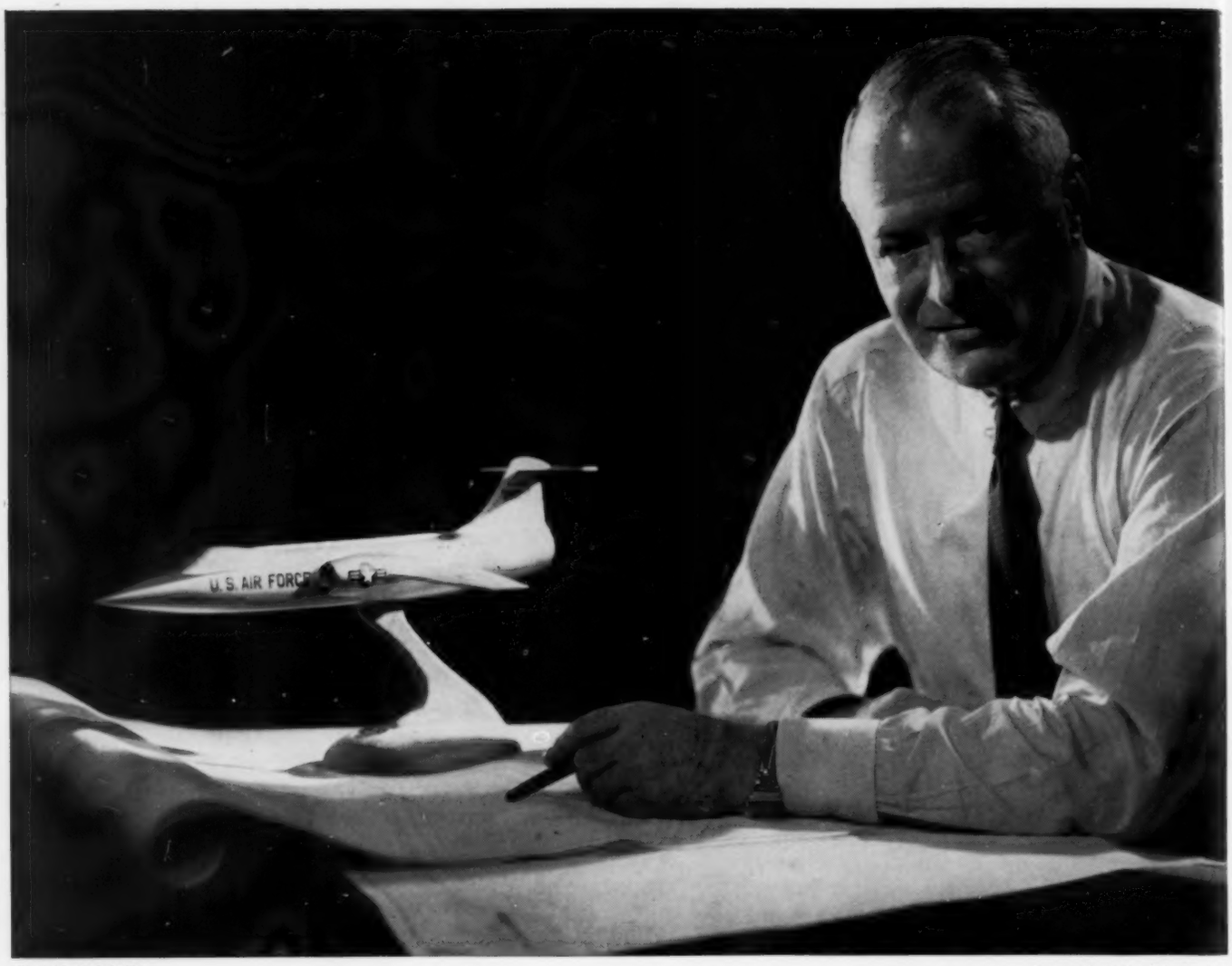
This process removes greater amounts of phenol from plant waste liquors and uses less quantities of caustic soda per pound of phenol. It directly produces a sodium phenolate solution of 35-40% strength without the use of concentrating steam.

Allied Chemical

WILPUTTE

COKE OVEN DIVISION

ALLIED CHEMICAL & DYE CORPORATION, 40 Rector Street, New York 6, N. Y.



ROBERT E. GROSS

Portrait by Fabian Bachrach

34,500 Lockheed Employees Regularly Buy U.S. Savings Bonds

"We in the Lockheed Aircraft Corporation family are proud of our record of participation in the U.S. Treasury's Payroll Savings Plan.

"It is important . . . particularly in these times . . . for all Americans to support our nation's programs and policies in every way. I know of no better way than the regular purchase of Savings Bonds.

"Our records show Bond-buying employees are saving at the weekly rate of $165,000 . . . a yearly total of approximately $9,000,000.

"This thrift, practiced regularly, is a vital keystone in building family security. It also makes a significant contribution to stabilization of the purchasing power of the dollar and the prevention of inflation.

"Each of our new employees is given the opportunity to join his fellow workers in the Payroll Savings Plan. We feel this is an important step in insuring America's future security and prosperity."

ROBERT E. GROSS, ***Chief Executive Officer, Chairman of the Board, Lockheed Aircraft Corporation***

A simple person-to-person canvass that puts a Payroll Savings Application Blank in the hands of *every* employee is all you have to do to install the Payroll Savings Plan or build employee participation in your present plan. Your State Sales Director is ready to help you. Write today to Savings Bond Division, U.S. Treasury Department, Washington 25, D. C.

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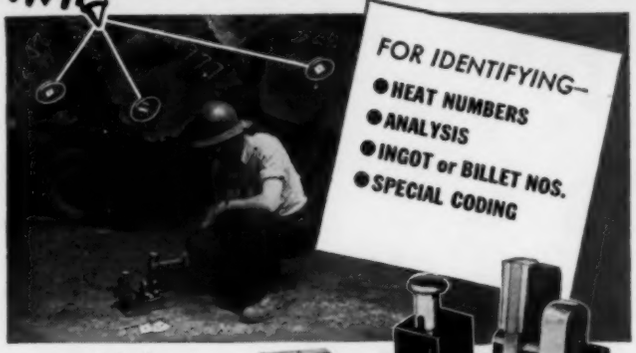
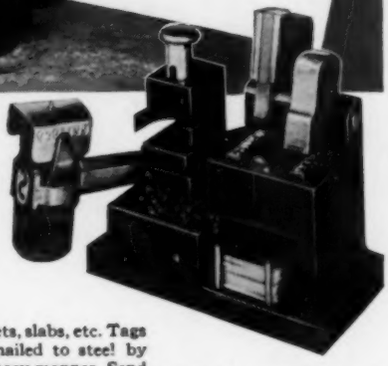


—with the

"SAFETY" TAG EMBOSSING and TAGGING OUTFIT



It's hard to believe, but it's true—this Outfit enables you to quickly nail metal identification tags to hot or cold steel ingots, billets, slabs, etc. Tags are embossed, pierced and nailed to steel by swinging hammer in the ordinary manner. Send for complete data today on this remarkable unit.

Write for Bulletin J-547

Mecco SAFETY MARKING TOOLS **M.E.CUNNINGHAM CO.**

1041 CHATEAU STREET, PITTSBURGH 33, PA.

A PRODUCT OF THE MARKING DEVICE INDUSTRY

SUCCESSFUL EQUIPMENT GROUTING easy as 1-2-3

1. READY-TO-USE. Add only water to Embeco Pre-Mixed Grout, mix and place to produce a...

2. . . . FLOWABLE easily-placed grout that hardens as a . . . .

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EMBECO PRE-MIXED GROUT

. . . Gives *lasting* results on every grouting job: heavy equipment, machinery, anchor bolts, building columns, bridge seats, etc.

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DIVISION OF AMERICAN-MARIETTA COMPANY

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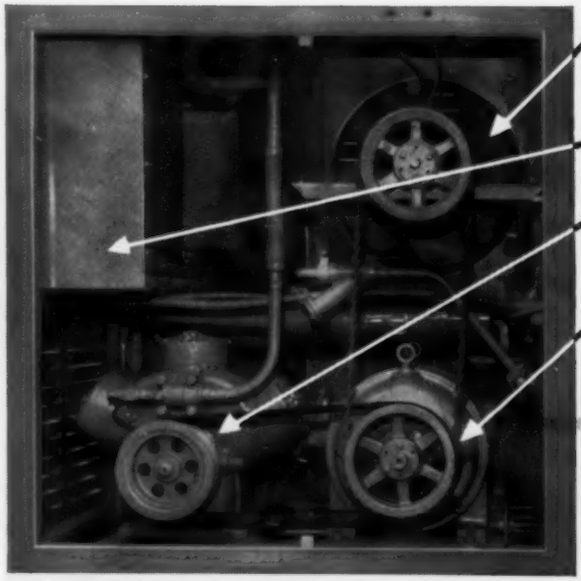
CLEVELAND 3, OHIO TORONTO 15, ONTARIO

Advance design of Dravo Cab Conditioners

cuts crane downtime



The heavy duty construction and sturdy components of Dravo Crane Cab Conditioners assure dependable service under the most severe operating conditions. This extreme dependability helps to cut costly crane downtime.

Shown at the left is the condenser section of Dravo's 7½ hp conditioner. The large access panels have been opened to show how easily maintenance can be performed from the front of the unit. Also, you can see some of the many features which add to the efficiency and reliability of Dravo Crane Cab Conditioners.

RUGGED CONDENSER-FAN ASSEMBLY—Air is forced, not pulled, through the condenser coils. Thus, when unit is opened for inspection, system operation continues and eliminates maintenance downtime.

DUST-TIGHT CONTROL CABINET—Electrical controls are protected from dirt, dust, and damage.

WEAR-RESISTANT COMPRESSOR—Heavy duty automotive type pistons with full pressure lubrication increase compressor life and efficiency.

HEAVY DUTY MOTOR—Class B insulation (standard equipment on 5 and 7½ hp compressor-condenser fan motors) assures efficient operation despite high ambient temperatures.

For more information about Dravo Cab Conditioners, write for Bulletin No. 1350-33, Dravo Corporation, Pittsburgh 22, Pa.

DRAVO CORPORATION

How to simplify control problems

Keep systems flexible, carry small inventory, cut maintenance cost with the **Bailey Building Block Method** of instrumentation and control.

What is the Bailey Building Block Method? It's using standardized Bailey measuring, transmitting, and controlling components and combining them into any system you need. Components can be added as needed . . . removed and reused elsewhere . . . recombined into another system when the need changes. It's flexibility plus!

It's all based on the simple fact that a Bailey instrument or control component doesn't care if the measured variable is fuel flow, percent oxygen, or furnace temperature, to pick just three examples. System components—transmitters, receivers, relays, selector stations, power units—are standardized for multi-purpose use.

A spare component can be used in any one of many systems. Gone are delays waiting for shipments of special parts. Gone are large inventories of spares and parts. Simplified is the training of men for maintenance.

There are many exclusive features and advantages of the individual components used in the Bailey Building Block Method. And there's much more to the Building Block story itself.

For further details, write to our Iron & Steel Division. Our engineers will be glad to prove how the Building Block approach will save you money and simplify your instrument and control problems.

G41-1

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BAILEY METER COMPANY

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In Canada—Bailey Meter Company Limited, Montreal

RESULTS IN: FLEXIBILITY, SIMPLICITY, ECONOMY

BAILEY METERS

Personnel News...

Harry B. Nicholson, formerly general superintendent of the Ashland Works, Armco Steel Corp., has been named assistant to the vice president of operations of the Armco Division. Mr. Nicholson joined Armco in 1924, when he was employed at the Ashland Works as a clerk in the production office. He held several other positions in the department and became supervisor in 1930. In 1940, he was also placed in charge of the shipping department at the plant. Mr. Nicholson was appointed assistant general superintendent in 1943. He was promoted to general superintendent of the Ashland Works in 1949, and held that position to the present. **George H. Todd** has been named general superintendent of the Ashland Works, succeeding Mr. Nicholson. **Townsell G. Marshall** succeeds Mr. Todd as assistant to the manager. Mr. Todd joined Armco in 1928. Starting as a laborer in the open hearth department of the Ashland Works, he advanced through various positions to assistant superintendent of the open hearth department in 1935. In 1941, Mr. Todd became assistant superintendent of the blast furnace department and, two years later, was named open hearth superintendent. He became assistant to the general superintendent in 1947, assistant general superintendent in 1949 and assistant to the manager earlier this year. Mr. Marshall joined Armco in 1941. He was named suggestion coordinator in 1951, personnel adviser in 1953 and supervisor of labor relations in 1956.

Anthony R. Palmer has been appointed superintendent of bar mills at the Cleveland steel plant of Republic Steel Corp. He succeeds **E. W. Carlson** who has been transferred to Buffalo, N. Y., as assistant district manager of the Republic steel plant there. Mr. Palmer was formerly turn foreman on the 10- and 12-in. mills.

J. Edward Maddox, senior industrial engineer at Armco Steel Corp.'s Ashland Works, has moved up to supervisor-labor relations. Mr Maddox joined Armco in 1941 as a checker in the industrial engineering department. He became a time study man in 1955, industrial engineer in 1956 and senior industrial engineer in 1957.

Ed O. Reese, general superintendent of flat rolled and tubular products, was named manager, Youngstown District, Youngstown Sheet and Tube Co. **John H. Stone,** assistant superintendent, Seamless Tube Mill Finishing Department, succeeds Mr. Reese as general superintendent, flat rolled and tubular products. Mr. Reese succeeds **J. S. Stanier** as Youngstown District Manager. Mr. Stanier retired October 1. Mr. Reese joined Youngstown Sheet and Tube in 1935 as an investigator in the Standards Department. Subsequently he held positions as an expeditor, assistant turn foreman, turn foreman, and general foreman, all in the Hot Strip Mill. In 1947 Mr. Reese was appointed assistant superintendent and was made superintendent in 1954. He was appointed general superintendent of flat rolled and tubular products in December, last year. Mr. Stone began his career in the steel industry in 1945 when he joined the Carnegie-Illinois Steel Corp. as a personnel assistant. The following year he became a junior industrial engineer with that company. He joined Youngstown Sheet and Tube in 1947 as an industrial engineer. Later he held positions as general foreman of the merchant mills at Struthers, assistant superintendent of the merchant mills and then assistant superintendent of the Cold Strip Department at Campbell before becoming assistant superintendent of the Seamless Tube Department.

George V. Hook has been named president and general manager of Armco, Paris. He will direct Armco International's activities in Switzerland, Spain, the Scandinavian countries, Holland, Austria, and other European and French colonial areas where Armco has distributors. He succeeds **Robert A. Solborg** who has retired. Mr. Solborg will continue to serve the company, however, on a consulting basis.

H. E. Baughman, vice president in charge of Portsmouth Division operations, Detroit Steel Corp., will retire December 1, 1957, completing his fortieth year of continuous employment at the Portsmouth plant. **A. E. Reinhard** was named general manager in charge of Portsmouth operations. He has been general superintendent of the plant since January 1, 1955. **J. F. Van Cleave,** formerly assistant to the vice president in charge of Portsmouth operations, was made assistant general manager. **F. C. McGough, V. O. Pentiuk** and **F. E. Weise, Jr.,** were appointed assistant general superintendents.

H. B. NICHOLSON

G. H. TODD

T. G. MARSHALL

A. R. PALMER

W. H. BETTS

L. C. BISHOP

L. G. MAECHTLEN

J. P. WETTACH

William H. Betts was appointed to the position of staff metallurgist of United Engineering and Foundry Co. Mr. Betts joined United in 1950 as a metallurgist in the research laboratory of the Canton, Ohio, plant. In 1955 he was appointed to the position of sales and service engineer in the Roll Division, which position he held until the present time.

Louis C. Bishop has been named district manager for the Pittsburgh sales office of Hagan Chemicals & Controls, Inc. Mr. Bishop started with Hagan in 1941 as a laboratory technician and has served successively as a Hall service engineer, headquarters staff engineer and Pittsburgh district office sales engineer.

Lawrence G. Maechtlen was named first vice president, Square D Co. A director and vice president of Square D since 1951, Mr. Maechtlen has, for the past three years, served as manager of the company's Western Division, which has a headquarters plant in Los Angeles. Mr. Maechtlen joined Square D as a draftsman in 1926, successively becoming chief engineer, works manager, district manager, sales manager and manager of the Western Division.

J. Philip Wettach has been named lubrication engineer for the Engineering and Construction Division of Dravo Corp. Mr. Wettach, who has been responsible for engineering on Dravo-DeLaval mill lubrication systems since he joined the company in 1955, succeeds **Kenneth D. Reed** who has retired. Prior to his employment by Dravo Mr. Wettach was employed by the DeLaval Separator Co. in its mill lubrication department, which was taken over in 1955 by Dravo.

L. E. Grafft has been appointed senior contracting manager in charge of the Pittsburgh district office of U. S. Steel's American Bridge Division. Mr. Grafft succeeds **James C. Hamilton,** who has been named assistant to vice president at the division's Los Angeles office where he will be in charge of all contracting matters in the western area.

John J. McDermott, formerly assistant manager of production of The Babcock & Wilcox Co.'s Barberton, Ohio, works, has been named production manager. His appointment fills the vacancy created by the transfer of **H. G. Lane** to the Barberton Works Manufacturing Engineering Department.

Richard C. Diehl was named as vice president of operations of Universal-Cyclops Steel Corp. He was formerly president of the Chase Brass and Copper Co. and served in various management and metallurgical capacities with Wheeling Steel Corp. and Armco Steel Corp.

James M. Darbaker was elected the chief executive officer of Copperweld Steel Co., filling the vacancy in that position caused by the recent death of **Frank R. S. Kaplan.** Mr. Darbaker will continue as president of the company and will also serve as acting chairman of the board of directors.

Robert E. Walsh has been appointed regional vice president of Blaw-Knox Co. in the Chicago area. The new position was established to consolidate responsibility in the area served by the company's three sales offices for over-all company relationships in civic, marketing and public relations matters. Mr. Walsh will continue to supervise roll sales activities in the Chicago area, a position he held prior to his new appointment. He has been associated with Blaw-Knox since 1937.

Thomas E. Turner has been appointed as sales representative for Leschen Wire Rope Division, H. K. Porter Co., Inc. His territory will include Virginia, West Virginia and North Carolina. Prior to this appointment he was a sales representative for Esso Standard Oil Co.

Joseph E. Praser has been appointed general superintendent of the Cleveland, Ohio, steel service plant of Joseph T. Ryerson & Son, Inc. He replaces **James J. Connaughton,** who becomes assistant to the general manager. Mr. Praser joined Ryerson at its Chicago plant in 1950. He became plant engineer at Cleveland in 1953 and two years later was made assistant superintendent. Mr. Connaughton was employed by the Otis Steel Co. until he joined the Bourne-Fuller Co. in Cleveland in 1919. He continued his career in the steel business with Ryerson when the latter company acquired Bourne-Fuller in 1927. He was appointed plant superintendent in 1937.

He may be closing against a fault.
He's not worried . . .

It's an

HPL-C
INTERRUPTER SWITCH

BUILT FOR SAFE OPERATION—
EVEN AGAINST SHORT CIRCUITS

Some day you may close an interrupter switch against a short circuit. For your safety, and the safety of your equipment, be sure your interrupter switches are HPL-C and operate with TOG-L SNAP mechanisms.

TOG-L SNAP—The high velocity blade operating mechanism. Optional, and important to safe closing-in operation.

RATINGS—Fused HPL-C Interrupters
Up to 14.4 Kv (110 BIL)
400 Amperes—(40,000 Amp. Mom.)
1200 Amperes—(60,000 Amp. Mom.)

SAFETY FEATURES—(1) HPL-C closes in on special heavy closing contacts, outside the interrupter—thus preventing damage to the interrupter switch when closing in on moderate fault currents; (2) High velocity "OVR-CENTR" blade closing (and opening) with the TOG-L SNAP operating mechanism—an optional feature, providing additional safety, important especially during the closing operation. For safety sake, specify these important features.

TESTS—Actual closing against moderate 3-phase fault currents at 4.8 and 13.8 Kv has proven that the HPL-C offers this protective feature. Ask the I-T-E Representative to give you the complete facts and details. They will show real economies on installation, operation and maintenance.

Supplied by leading electrical equipment assemblers, switchboard builders and transformer manufacturers in switchboards and unit substations.

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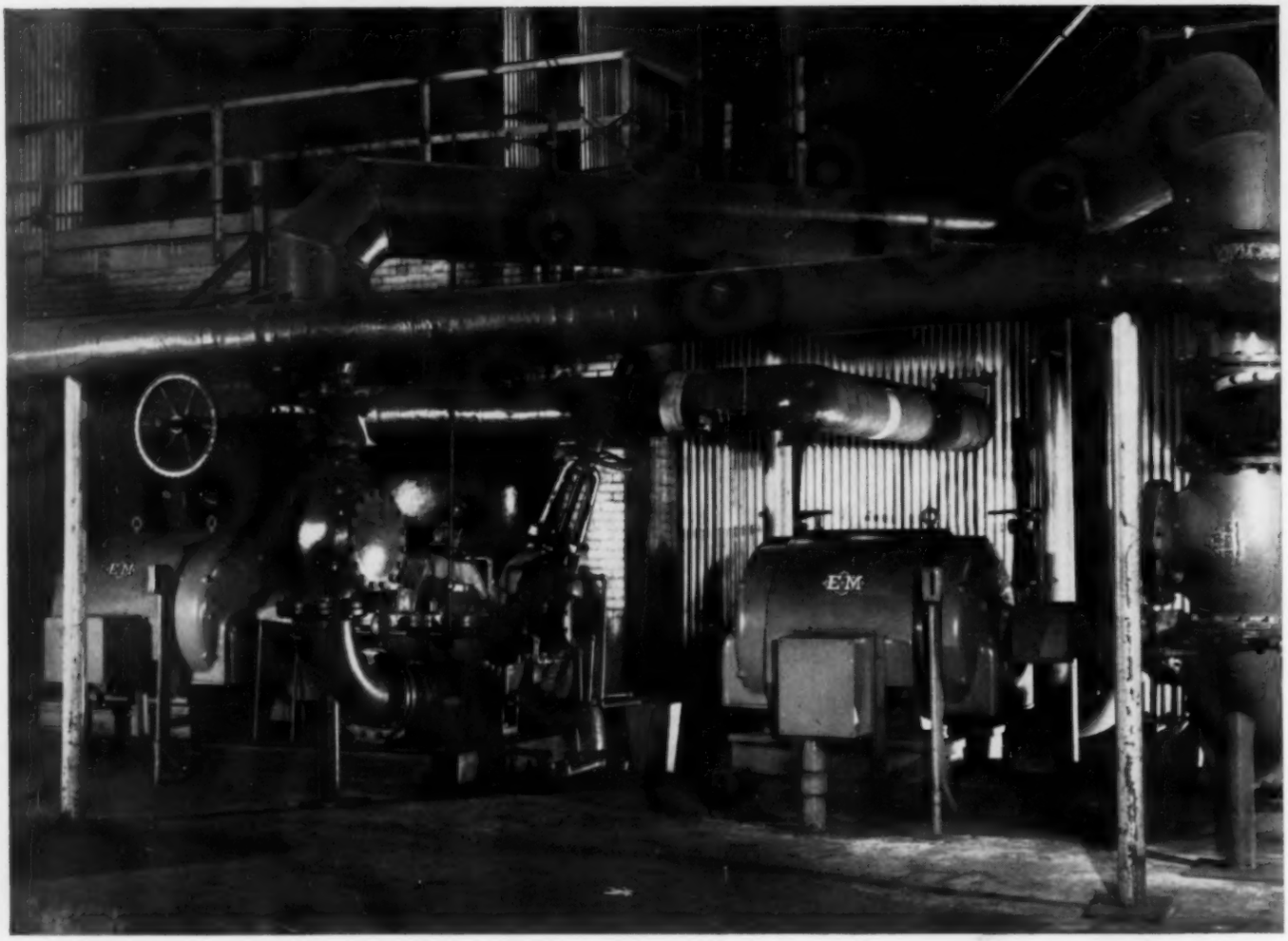
I-T-E CIRCUIT BREAKER CO.
GREENSBURG, PA.

HPL-1



Jones & Laughlin Steel Corporation enjoys low maintenance costs on large motor drives

● Safeguarding motor operation in a steel mill is an important factor in the mill's over-all profitable operation. Motor shut down means costly maintenance projects and large production losses. Bearing failures and winding burn outs are no longer considered inevitable, and today's mill operators who are interested in continuous high-level production are taking advantage of modern motor design to insure against motor failure.

The two 400 hp, 1450 rpm, splash-proof E-M Squirrel-Cage Induction Motors above show how Jones & Laughlin Steel Corporation engineers use modern motor design to protect against motor outage. These motors, which drive centrifugal pumps supplying water to three hot strip-mill furnaces at the Pittsburgh works, have given year-in, year-out service with only routine bearing lubrication and inspection. E-M *Protective Construction* keeps water and foreign material out of vital parts, so essential to uninterrupted, trouble-free operation.

And remember, *Protective Construction* means more than physical shielding of windings and bearings with splash-proof or other protective enclosures. It includes the E-M "know-how" of motor design and special attention to the smallest details of construction. Here are some of the important features in E-M *Protective Construction:*

1. Windings custom designed for the application, repeatedly processed to keep moisture out.
2. Coil ends methodically lashed to heavy rings to prevent movement during repeated starting surges.
3. Bearings precision engineered and processed for cool, long-life service.
4. And rotors of practically indestructible cage construction, accurately balanced for vibration-free operation.

For your next *special* motor application call on your local E-M sales engineer for helpful counsel. Let him show you how E-M *Protective Construction* can help keep your maintenance costs low on large motor drives. And write the factory for E-M Foto-Facts No. 16, showing other modern motor applications in a modern steel mill.

ELECTRIC MACHINERY MFG. COMPANY
MINNEAPOLIS 13, MINNESOTA

E-M

1300-TPA-2167

Specialists in making motors do **EXACTLY WHAT YOU WANT THEM TO**

J. George Miles has been appointed assistant to **L. H. Juengling,** vice president of Armco Steel Corp. in charge of the Sheffield division. Mr. Miles was formerly director of personal relations for the Sheffield Division and, in his new capacity, will continue to make his headquarters in Houston. He began his steel industry career by going to work for the Kansas City Bolt & Nut Co., which later became Sheffield Steel. He started as a production clerk in 1923, and worked at Kansas City in various capacities in accounting, purchasing and operations. He was transferred to the Houston plant prior to the start of operations in 1942 and served as personnel manager until 1948, when he was made director of personal relations for the entire Sheffield division.

D. B. Perlis has been named product sales manager in charge of co-ordinating Western Precipitation Corp.'s Dualaire sales. He was formerly technical and sales engineer.

D. B. PERLIS

W. C. Higdon, assistant works manager of Armco Steel Corp's Sheffield Division Houston Plant, for the past five years, was appointed works manager to succeed **F. Ray McFarland,** who died August 29. Works metallurgist **K. P. Campbell** was appointed general superintendent of operations in charge of all phases of production and **C. L. Lloyd, Jr.,** formerly superintendent of ore and coal mining, was named general superintendent of services, including maintenance and other plant services. In other promotions, **A. O. Leweke** was named works industrial engineer; **G. W. Brooks** succeeded Mr. Campbell as works metallurgists; **C. H. Bone** was named processing analyst; **H. H. Olsen** assistant works metallurgist, **G. C. Stanley** supervisor of employment, and **V. F. Herbster** assistant superintendent of the rolling mills.

Jacob W. Cox was named general superintendent of the Duluth Works of American Steel and Wire Division, U. S. Steel Corp. He succeeds **C. A. Purbaugh,** who has been named assistant manager of operations of the Duluth district. Mr. Cox was first employed by American Steel and Wire in 1936 as an observer in the physical laboratory at the firm's Donora, Pa., plant. By 1944 he had been advanced to turn foreman in the blast furnace department at the plant. In 1946, he was promoted to general foreman of blast furnaces at American Steel and Wire's Central Furnaces and Docks in Cleveland, Ohio. In 1949, he was made division superintendent of blast furnaces at the Donora plant, and later became assistant to the general superintendent. On September 1, 1956, he was appointed director of raw materials in the office of the vice president in Cleveland, and leaves this post to accept his new assignment in Duluth.

George P. Hansen, assistant vice president in charge of steel plants of Wheeling Steel Corp., retired as of October 1. He will continue as a consultant for a period of time. Mr. Hansen has been associated with Wheeling Steel since 1941, when he was appointed general manager of the Benwood, W. Va. Works. He has been in his present capacity since 1944.

Robert A. Rothacker was appointed superintendent and **George E. Harlan,** general foreman at Republic Steel Corp.'s Union Drawn Steel Division plant in Beaver Falls, Pa. Mr. Rothacker succeeds **H. B. Anderson,** whose appointment to assistant division manager of Union Drawn at its Massillon, Ohio, headquarters, also was announced. Mr. Harlan will aid Mr. Rothacker in the direction of all operations at the plant.

Dr. T. E. Dancy has been promoted to research supervisor in the Research Division of Jones & Laughlin Steel Corp. Dr. Dancy, formerly senior development engineer, has been with J & L in its Research and Development Department, since September, 1956. He formerly was associated with the British Iron and Steel Research Association in London, England. In 1953 and 1954, he was metallurgical adviser to the United Kingdom Scientific Mission, a Department of the British Embassy, in the United States.

Joseph W. Rath was promoted to superintendent and **T. A. Thompson** to assistant superintendent in the open hearth department of Weirton Steel Co. Mr. Rath began his employment with Weirton in 1928 as a first helper in the open hearth department. He later became a melter, then a melter foreman, and in 1948 became assistant superintendent, the position he held prior to his current promotion. Mr. Thompson began his Weirton employment in 1937 as a wireman in the strip steel department. He performed jobs in the strip steel, sheet mill and steel works prior to going to the open hearth as gas container engineer. In 1951 he was named assistant turn foreman in the open hearth and held that position until his promotion to assistant superintendent.

James P. Raugh, has been named vice president and general manager of the Refractories Division, H. K. Porter Co., Inc. Mr. Raugh previously has been vice president of operations for General Refractories Co.

Henry F. Kelly has been named superintendent, and **Eugene R. Mackey,** assistant superintendent of the coke plant at Republic Steel Corp.'s South Chicago operations. Both Mr. Kelly and Mr. Mackey have served at the coke plant since its completion during World War II, Mr. Kelly as general foreman and Mr. Mackey as turn foreman.

Dexter Baker, former general sales manager of Air Products, Inc., has been named managing director of

the newly-formed Air Products, Ltd., and will be responsible for all phases of marketing, engineering, manufacturing and operations. Administrative offices are located in London. The firm has been organized by Air Products, Inc., and Butterley Co. of London.

Howard H. Nichols was appointed to the position of Sales Manager, Hazen Engineering Co. Mr. Nichols was formerly with Columbia-Geneva Division of United States Steel Corp.

Dr. L. I. Dana has been appointed vice president—research and development, and **David Swan** appointed director of research of Linde Co., Division of Union Carbide Corp. Dr. Dana had been vice president—research for Linde. Mr. Swan had been director of research of Metals Research Laboratories, Electro Metallurgical Co., Division of Union Carbide.

Arthur M. Over has been elected a vice president of the Rust Engineering Co. He had been a project manager and formerly had served as director of purchases from 1952 to 1955. Mr. Over joined Rust Engineering as a field engineer in 1946. He was made a construction superintendent in 1949 and two years later was transferred to the Pittsburgh office as an assistant project manager.

David E. Weaver was named superintendent and **Charles N. Treat** was named assistant superintendent at Republic Steel Corp.'s South Chicago plant. Mr. Weaver will direct operations of the plant's 10- and 12-in. bar mills, bar finishing, heat treating and spike departments, and Mr. Treat will assist in the direction of these departments.

Fred E. Theis was named superintendent of shops, and **Norman P. Hitchcock,** was named superintendent of maintenance and power at the Indiana Harbor Works of Youngstown Sheet and Tube Co. Mr. Theis started his Youngstown career in 1937 in the carpenter shop at the Campbell, Ohio, Works. At the time of his promotion he was shops planning engineer at the Campbell Works. Mr. Hitchcock joined the company in 1933 as a power house repairman in the electrical department. He served in various supervisory positions including chief electrical inspector, general foreman and assistant superintendent of maintenance. At the time of his promotion he was superintendent of maintenance at the company's Brier Hill plant.

N. W. Hocking, Jr., has been appointed chief plant engineer of Wheeling Steel Corp.'s Yorkville, Ohio, Works. He began his Wheeling Steel career in 1949 as a practice engineer at the Steubenville Works. Two years later, he was assigned to the position of electrical engineer at that plant. He served in various supervisory capacities at the Steubenville Works until 1955, when he was appointed project engineer at the Yorkville operation. Last year, Mr. Hocking was named assistant chief plant engineer at Yorkville.

John V. Boardman was named vice president and general manager of the Green River Steel Corp. in Owensboro, Ky., a subsidiary of Jessop Steel Co. Also, **J. B. Riley** was named secretary and controller of Green River Steel. Mr. Boardman joined Green River Steel in 1954 as general superintendent and later the same year he was promoted to vice president—operations. He has been in the steel industry 28 years, 17 with Jones & Laughlin Steel Corp.

Obituaries

G. Stewart Crane, 69, chairman of the board of directors of Cutler-Hammer, Inc., died September 28. Mr. Crane joined the company in 1910. Two years later he was transferred to the company's Pittsburgh district sales office and in 1916 was named manager of the Cleveland district sales office. Mr. Crane returned to Milwaukee in 1921 to become manager of the firm's controller division. He successively served as general sales manager, vice president in charge of sales, and vice president in charge of sales and engineering before being elected president in 1945. He was elected chairman of the board of directors and chairman of the newly created plans committee in 1955, posts which he held at the time of his death.

Harold S. Falk, president of The Falk Corp. died October 7. He was 73.

Philip J. Wenz, manager of the service and repair division of De Laval Steam Turbine Co., died September 11. He was 63.

Mathew G. Sternberg, 68, former president of the Continental Foundry & Machine Co., died September 4. Mr. Sternberg was a consultant for Blaw-Knox Co., East Chicago, Ind., after acquisition of Continental by Blaw-Knox in 1955.

The overwhelming majority of cranes and pulpits being equipped with air conditioning are Lintern equipped.

The reasons for this are contained in new, 20-page Bulletin AC-573 which describes Aire-Rectifiers for each temperature range of cab, also models for pulpits.

Write for copy today.

Larco, inc.

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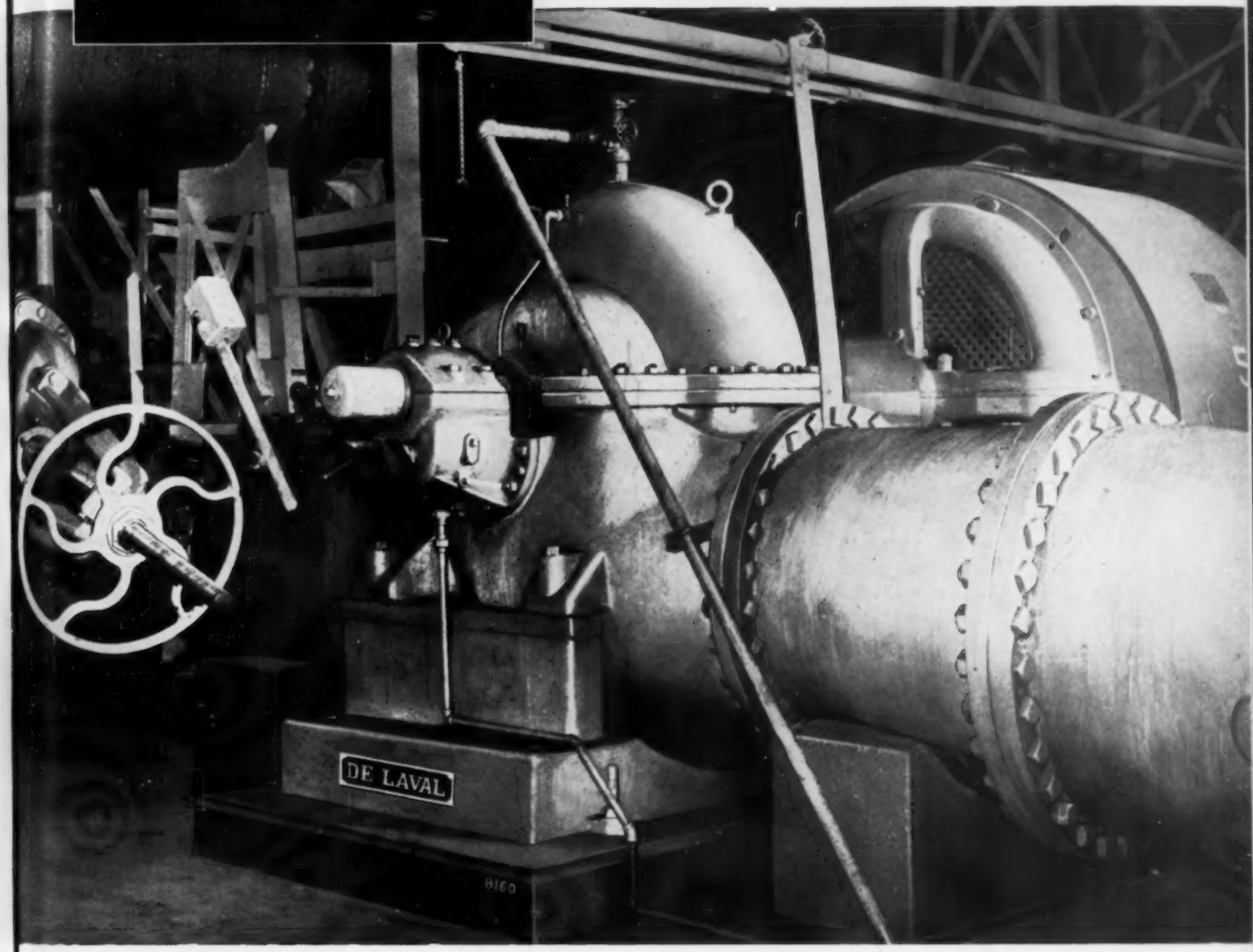
Call or Write STAMCO for...

Corrugating and Complete Line of Culvert Equipment—Slitting and Coiling Equipment for Ferrous and Non-Ferrous Material in All Capacities—Warehouse and Steel Mill Cut to Length Lines for Shearing and Levelling Sheets from Coils—Shears for Shearing Sheets and Plates Both Underdriven and Overdriven Types in all Capacities up to 1¼" plate.

STAMCO, Inc., New Bremen, Ohio

DE LAVAL
CENTRIFUGAL PUMPS

in service since 1911 at Inland Steel Co.



De Laval Centrifugal Pumps have a record of dependability at the Inland Steel Co., which goes back forty-five years. In that time, De Laval has supplied this major producer with pumps for practically every steel mill service—*more than 75 units in all.* The photograph shows one of the largest De Laval pumps on the line at the East Chicago, Indiana plant of Inland Steel. The unit delivers 20,000 gpm at 120 ft head.

De Laval Centrifugal Pumps are available for a wide range of applications in all types of metal-working plants. Types L, M and P single stage double suction pumps can handle capacities from 1,000 to 20,000 gpm and heads to 350 feet. Larger De Laval units of any capacity to meet any requirement for steel mill service are available.

Send for Bulletin 1004 giving performance and application data.

DE LAVAL *Centrifugal Pumps*

DE LAVAL STEAM TURBINE COMPANY
870 Nottingham Way, Trenton 2, New Jersey

DL.388

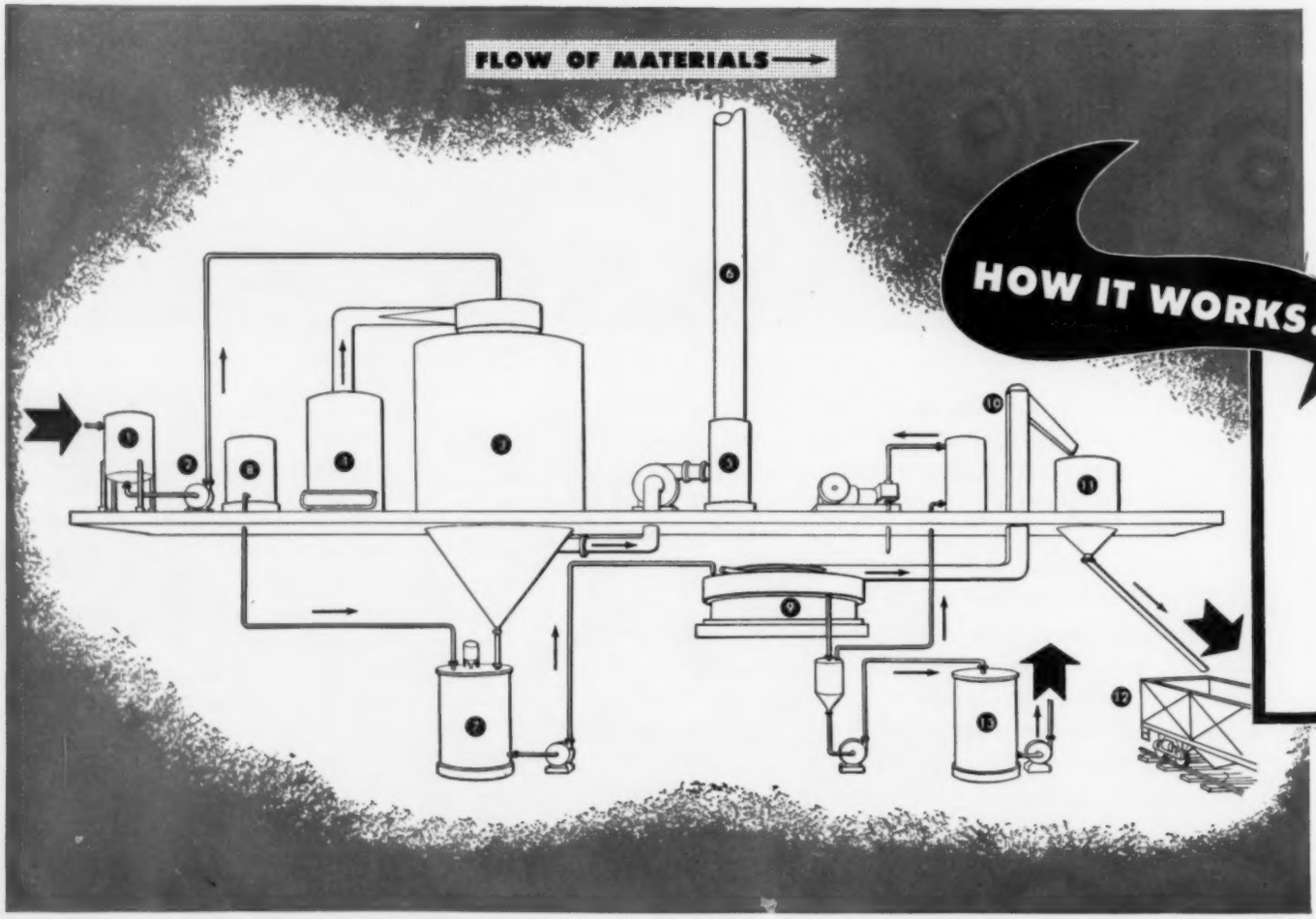
If you operate a

CUT ACID REQUIREMENTS

New continuous process, available from Koppers, of pickling acid used . . . and eliminates waste

FOR OVER A QUARTER OF A CENTURY, wherever a pickling line has been in operation, disposal of spent liquor has been a major headache. But now a new continuous regeneration process—the Koppers Inland-Zahn process— goes a long way toward solving this problem. This system is simple, it is economical, and *it has been proved in actual plant-scale commercial operation in Europe.*

With this process, the only make-up acid needed is the amount consumed in the pickling reaction plus normal losses. *All* available free acid in the used liquor is recovered (up to 50% of the original charge). Labor costs are low—just one man can operate the entire regeneration plant. As a result of these savings, operating costs are substantially below those of any presently available disposal method.



pickling line

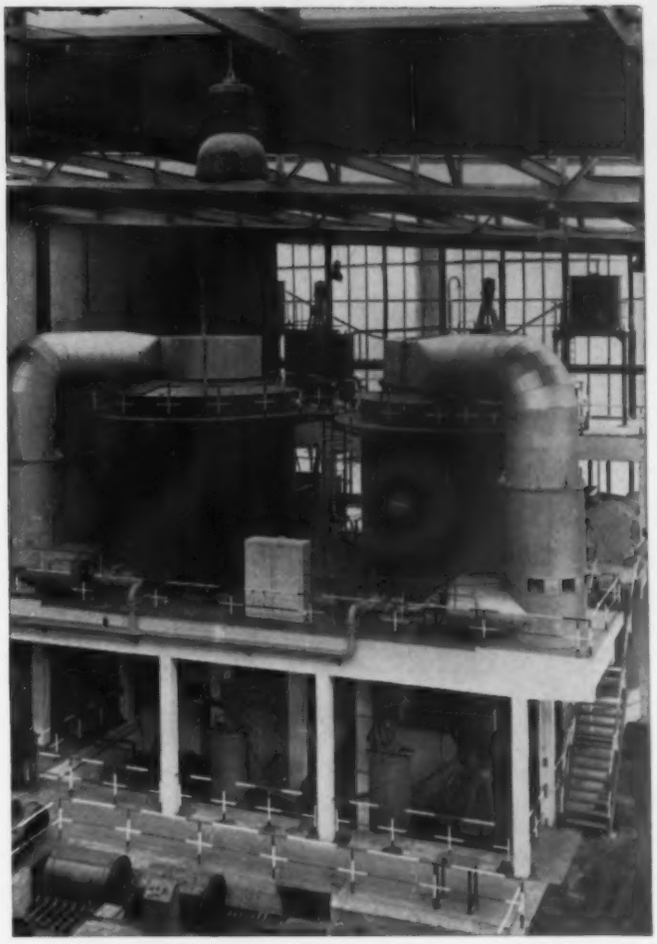
IN HALF!

regenerates up to half liquor disposal problem

PROVED COMMERCIALLY—This process, developed by Inland Steel Company and adapted commercially by Zahn & Co. of West Germany, is now being used successfully in three European steel plants. The benefits achieved include *extremely low maintenance* . . . and more uniform and *higher* acid concentrations in the baths. The latter advantage permits faster steel processing.

NEUTRALIZING PLANTS – The new regeneration process is especially applicable to plants handling 10,000 gallons of effluent, or more, a day. The Chemical Department of Koppers Engineering and Construction Division also designs and builds lime neutralization systems for both large and small pickling operations. Send the coupon for complete information about these and other Koppers Chemical Engineering Services.

Spent pickle liquor (1) is pumped (2) to spray head in an evaporating chamber (3). Here, hot air and flue gases from a combustion chamber (4) concentrate the liquor and cause the ferrous sulfate monohydrate to crystallize out of solution. Vapor laden air is discharged to atmosphere through a mist eliminator and stack (5 and 6). The slurry is dropped into a crystallizing tank (7) where fresh sulfuric acid is added from a metering tank (8). This causes more monohydrate to drop out. The slurry is then separated in a vacuum filter (9) and washed. Salt is conveyed to bins or hopper cars for sale or disposal (10, 11, 12). Mother liquor, containing about 35% acid and 1-2% iron, is pumped to a holding tank (13), ready for dilution and return to the pickling tanks. No reheating is required.



HEART OF THE SYSTEM—This spray dryer concentrates spent liquor to slurry of ferrous sulfate monohydrate crystals suspended in acid. The plant shown here, in Germany, has operated since June, 1954, processing 48,000 gallons per day of waste liquor.

GET ALL THE FACTS!

Koppers Company, Inc.
Engineering and Construction Division
1451 Koppers Building
Pittsburgh 19, Pennsylvania

I would like to receive literature on this new pickle liquor regeneration process . . . and also on Koppers other chemical engineering services. Please send the following:

- ☐ **Regeneration of steel pickling solutions by Koppers Inland-Zahn process.**
- ☐ **Lime neutralization of spent pickle liquor by Koppers.**
- ☐ **"3 Keys to Selecting Your Industrial Contractor," a brochure describing the variety of Koppers construction services and giving reasons why Koppers should build your next chemical plant.**

Name_____

Title_____

Firm_____

Address_____

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KOPPERS

KOPPERS

CHEMICAL ENGINEERING SERVICES

"No secondary cleaner required with a P-A Washer"

...says FURNACE SUPERINTENDENT

This economical feature of the Pease-Anthony washer is only one of the many reasons why P-A is first choice with blast furnacemen.

It's a "natural" where high top pressures are used . . . puts full top pressure to work cleaning gas . . . low water consumption . . . low initial cost with minimum maintenance requirements . . . compact design requires little space.

Units available for capacities ranging up to 150,000 SCFM. Write for descriptive bulletin.

Performance summary of some P-A Washers now in use:

Installation	Years Operated	Volume SCFM	Pressure Drop Inches Water	Dust Loading Grains/SCF Inlet	Outlet
A	4	78,000	30	3-19.0	.01-.04
B	3½	78,000	30	2-3	.02-.08
C	3	85,000	30-40	2-3	.01-.03
D	3	45,000	30	2	.02-.03
E	½	75,000	50	—	.02
F*	½	26,000	12	5	.10
G*	½	26,000	12	5	.10
H	½	90,000	29	—	.04

Installation C is in Illinois. Installation H is in Texas. All others are in Pennsylvania.

*Two units in parallel on one furnace. Lower efficiency due to lower available top pressure.

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P-A GAS SCRUBBERS

CHEMICAL CONSTRUCTION CORPORATION

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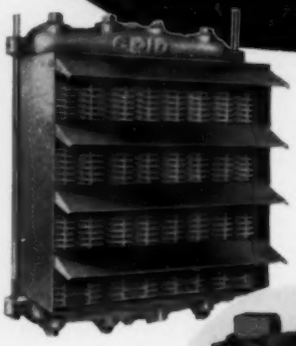
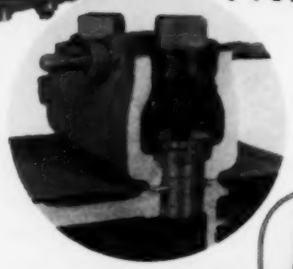
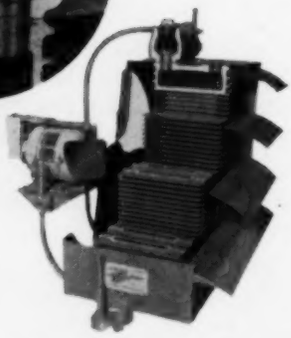
GRID Cast Iron - Steam Heat Transfer Surface



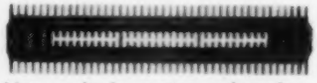
...ends Unit Heater Maintenance Problems!



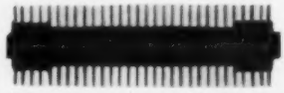


Your answer to unit heater problems the steel industry has discovered through common failures of copper, aluminum and steel tube heat transfer surface. GRID condenser eliminates internal electrolytic corrosion—because all metals in contact with steam are similar. GRID also eliminates external corrosion—because the cast iron construction resists acid or other fumes in the air and eliminates the use of reducing valves where high steam pressure is used. GRID cast iron construction is tested to withstand steam pressures up to 250 P.S.I. . . .450° temperature . . . no soldered, brazed, welded or expanded connections . . . a specially designed threaded nipple provides a leakproof joint. GRID eliminates the high maintenance costs generally experienced with other types of condenser construction. . . eliminates replacement costs because GRID is built to last for years . . . uninterrupted service records of more than twenty years are common among GRID users.

Cut-away view of Model 2000 GRID Unit Heater . . . note double steam chambers in each fin section and wide fin spacing.



Note wide fin spacing and ample radiation surface in all cast iron, one-piece, single chamber fin sections, used in Models 1000 and 1200 GRID Unit Heaters.



All cast iron, one-piece, double chamber fin sections used in Models 1500 through 3000 GRID Unit Heaters. . . wide fin spacing prevents clogging and is easily cleaned.

Send for the complete story on GRID Unit Heaters, GRID Blast Heaters and GRID Radiation for steel industry use. . .it is contained in GRID Products Catalog No. 956. Write today for your copy.

D. J. MURRAY MANUFACTURING CO.

MANUFACTURERS SINCE 1883

WAUSAU, WISCONSIN

Christmas lives in the joy and satisfaction of the giver...

...and in the delight and thankfulness of those who receive

Almost everybody remembers

to make Christmas Seals a part of his giving...

because they give the greatest gift of all,

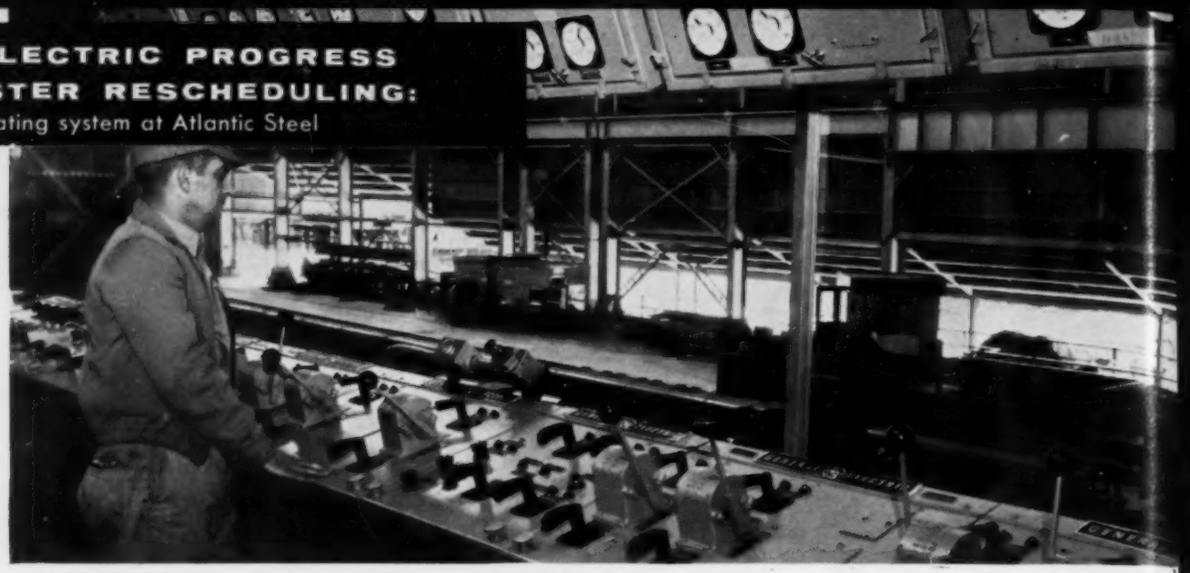
health, life itself, to so many.

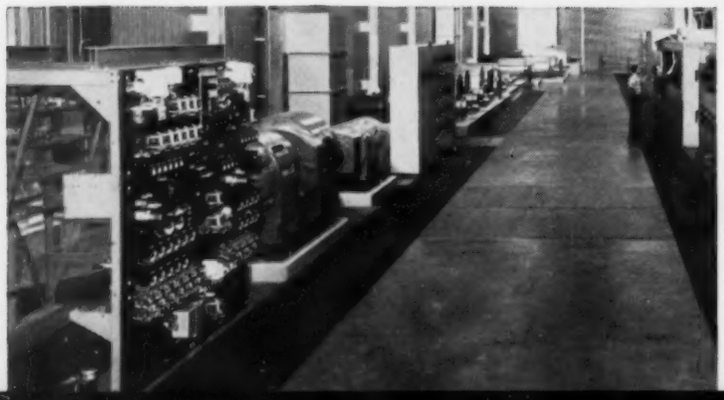
How about you?

IRON AND STEEL ENGINEER

GENERAL ELECTRIC PROGRESS TOWARD FASTER RESCHEDULING:

Speed-regulating system at Atlantic Steel



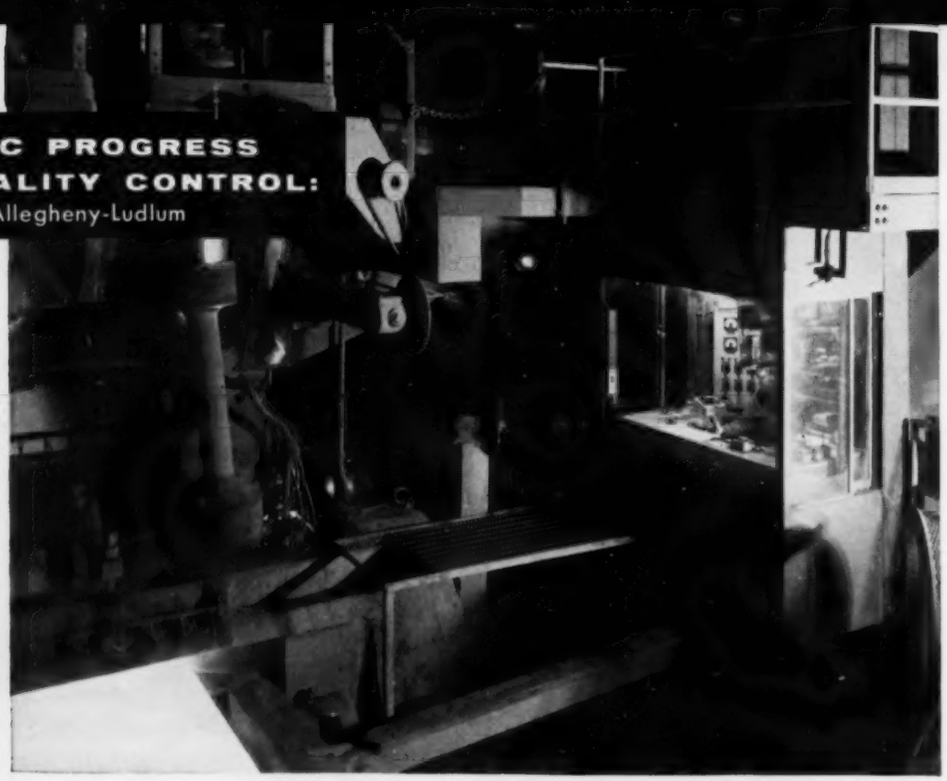


COMBINATION MERCHANT BAR AND ROD MILL at Atlantic Steel is one of world's fastest. Powered by a G-E co-ordinated drive system, it has a top speed of 5000 fpm for rods, 2000 fpm for merchant products. Pumpless ignitron rectifiers supply d-c power to main drive motors totalling 8450 hp. Centralized operator's control shown co-ordinates mill operations, permits using trained manpower most efficiently.

NEW AMPLISTAT-AMPLIDYNE SPEED REGULATING SYSTEM for mill motors holds 0.25% steady-state speed error from no-load to full-load, permits setting no-load speed essentially equal to rolling speed. This provides faster setting up and rescheduling. Faster response is also obtained to reduce over- and under-feed caused by impact speed drop, thereby minimizing buckling and pulling in the rod or bar.

GENERAL ELECTRIC PROGRESS TOWARD CLOSER QUALITY CONTROL:

Card program system at Allegheny-Ludlum



FOR FIRST TIME in the steel industry, a G.E.-developed punched-card system automatically programs and controls roll openings and mill speed on Allegheny-Ludlums Brackenridge reversing rougher, permitting closer tolerances, closer quality control.

GREATER PROCESS FLEXIBILITY is provided by G-E card program control. Using standard punched card compatible with accounting, data logging, and processing systems, operator can maintain large number of optimum schedules, for wide variety of products. A 15-pass schedule and product data is programmed on one card. Operator selects desired card, inserts it in "card reader" (see photo), and pushes "next pass" button to start each pass. Card control system automatically sets the screw position and mill speed for the pass. System's accuracy is 0.010 inches with maximum opening of 9.99 inches. Settings are provided every 0.01 inches.

GENERAL ELECTRIC PROGRESS TOWARD GREATER PRODUCTION:
Higher speed with automatic gage control at Weirton Steel Division, National Steel Corp.

MORE AUTOMATIC OPERATION at Weirton Steel's new 5-stand tandem cold mill is provided by G-E automatic gage control. Shown below are X-ray indicator for Stand 1, X-ray gage, and operator's main control panel.

WORLD'S MOST POWERFUL, Weirton's new cold strip mill contains G-E drives totalling 28,000 hp. Specially designed to fit mill's rigid space needs, G-E low-inertia d-c drive motors (above) provide fast acceleration and balanced speed regulation. Automatic gage control, developed by G.E. for the steel industry, helps this mill produce higher quality steel, with closer tolerances, at higher rolling speeds. System utilizes X-ray gages at Stands 1 and 5 controlling thickness through screwdown position at Stand 1 main drive motor speed at Stand 5.

THESE EXAMPLES OF DRIVE-ENGINEERING PROGRESS SHOW . . .

General Electric systems contribute to steel industry's increase in productivity

As the steel industry accelerates its evolution from mechanization to automation, there is an increasing trend to larger machinery, higher processing speeds, and greater production capabilities. Keeping pace with this trend, General Electric is constantly developing the new and improved electrical techniques, systems and equipment required.

For example, horsepower levels on main and auxiliary drives are being raised, greater precision in automatic control is being achieved, and new methods of electrically regulating and programming work in progress are being used. New steel-mill drive systems are being designed —in close co-operation with steel industry engineers and machinery builders—to fit the still newer developments anticipated tomorrow. And system equipment continues to stress dependability and minimum maintenance to keep steel mill productivity high.

A few examples of General Electric developments along these lines are shown here. To serve *your* needs for automating electrically, profit from G.E.'s complete engineering services and system-engineered electric equipment. Contact your nearest General Electric Apparatus Sales Office. General Electric Co., Schenectady 5, N. Y.

659-118

Engineered Electrical Systems for the Steel Industry

GENERAL ELECTRIC

SELAS CONTINUOUS STRIP ANNEALING BOOSTS CAPACITY 400,000+ TONS/YEAR

This steel mill is meeting current production demands and setting the stage for the future with its installation of four 15-ton/hr Selas single-pass annealing lines.

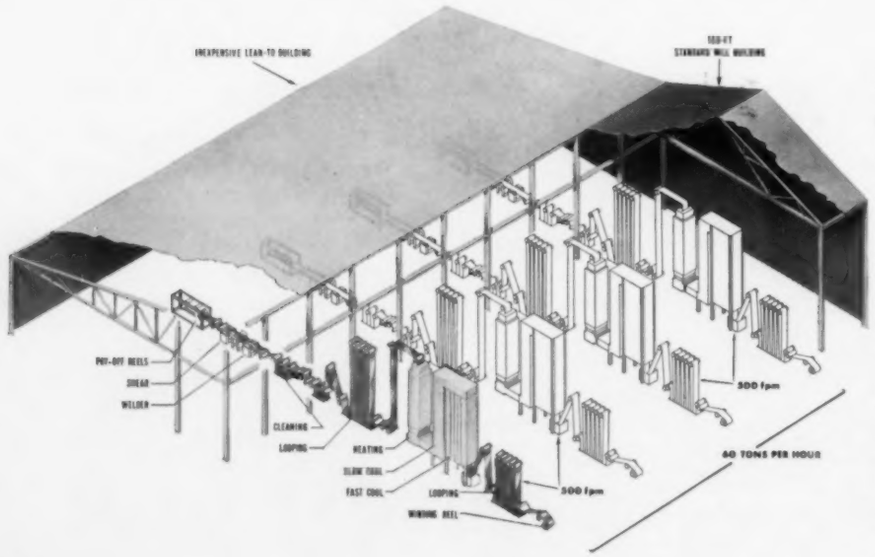
Cooperative research with Selas and years of operating experience in continuous strip heating at the mill indicated that a 500 fpm strip speed provided the most economical operation to meet the current requirements of this steel producer. High prime yield, relatively few interruptions, ease of mechanical alignment, lower maintenance, were other considerations which dictated the use of this single-pass, direct-fired concept of annealing.

To meet desired increased capacity of 60 tons per hour, four such lines were installed *across* a normal mill building, thereby saving space and avoiding special plant construction.

After a year of production operation, the mill reports these advantages from the Selas multi-line installation:

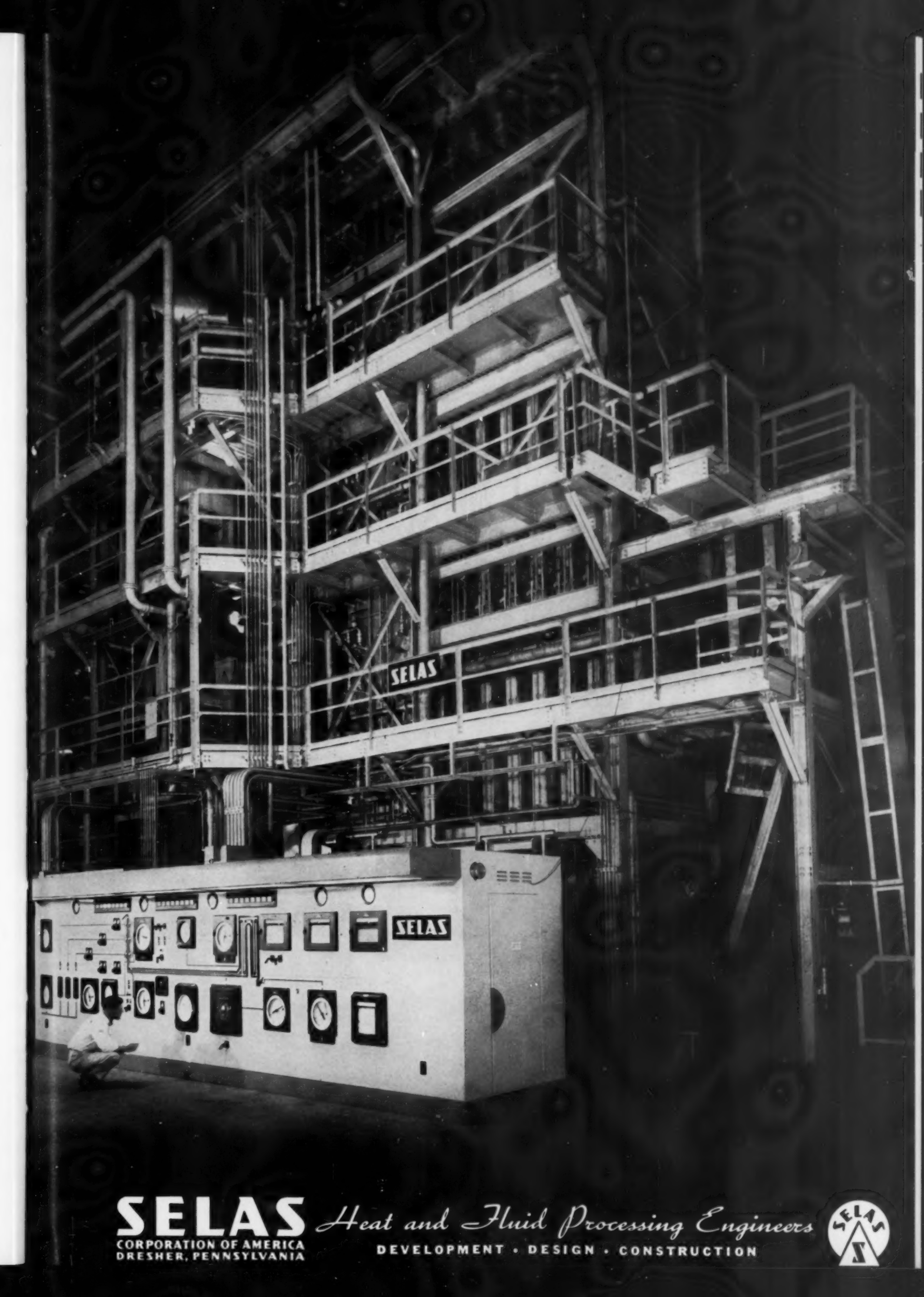
- Continuous hour-after-hour production of prime strip
- Great flexibility of scheduling to meet simultaneously the needs of several customers
- Simplified material flow patterns with lighter material handling equipment
- Economical, easily-maintained equipment of simple design
- Provision for market trend toward wider, lighter-gauge strip
- Operating ease, especially in change-over, start-up and strip-rethreading
- Minimum number of passes with few rolls (none in high temperature section) for high mechanical and electrical efficiency
- Conservative production rating—already exceeded—that can be significantly increased, if desired, by simple, inexpensive alteration to furnace

In another mill, one Selas line is annealing 30 tons of steel strip per hour. Still higher production rates are readily attainable using single-pass, direct fired heating. Our engineers will be glad to discuss how Selas Gradiation® methods can be tailored to your strip processing needs. Address Dept. 411, Selas Corporation of America, Dresher, Pa.



The four Selas lines, including cooling sections and looping towers, are installed in 100-ft conventional mill building. Handling equipment at each end of line is installed in relatively inexpensive lean-to-type structures so that flow of material is across building. Arrangement provides for economical expansion when required.

Compact Selas Control Cubicle saves valuable floor space and permits easy access to instruments, while graphic front panel functionally delineates process and control system of this continuous annealing line. It presents operating information more accurately and pictorializes process conditions and functioning of the production line. The flow diagram shows strip passing through Selas single-pass vertical furnace (located at center of panel) through controlled-cooling section (at right). Gas combustion control and temperature, strip speed, and atmosphere composition indicators are related to the diagram at points of operation. Heat input is controlled by integrating strip speed, fuel input and strip temperature measurements.

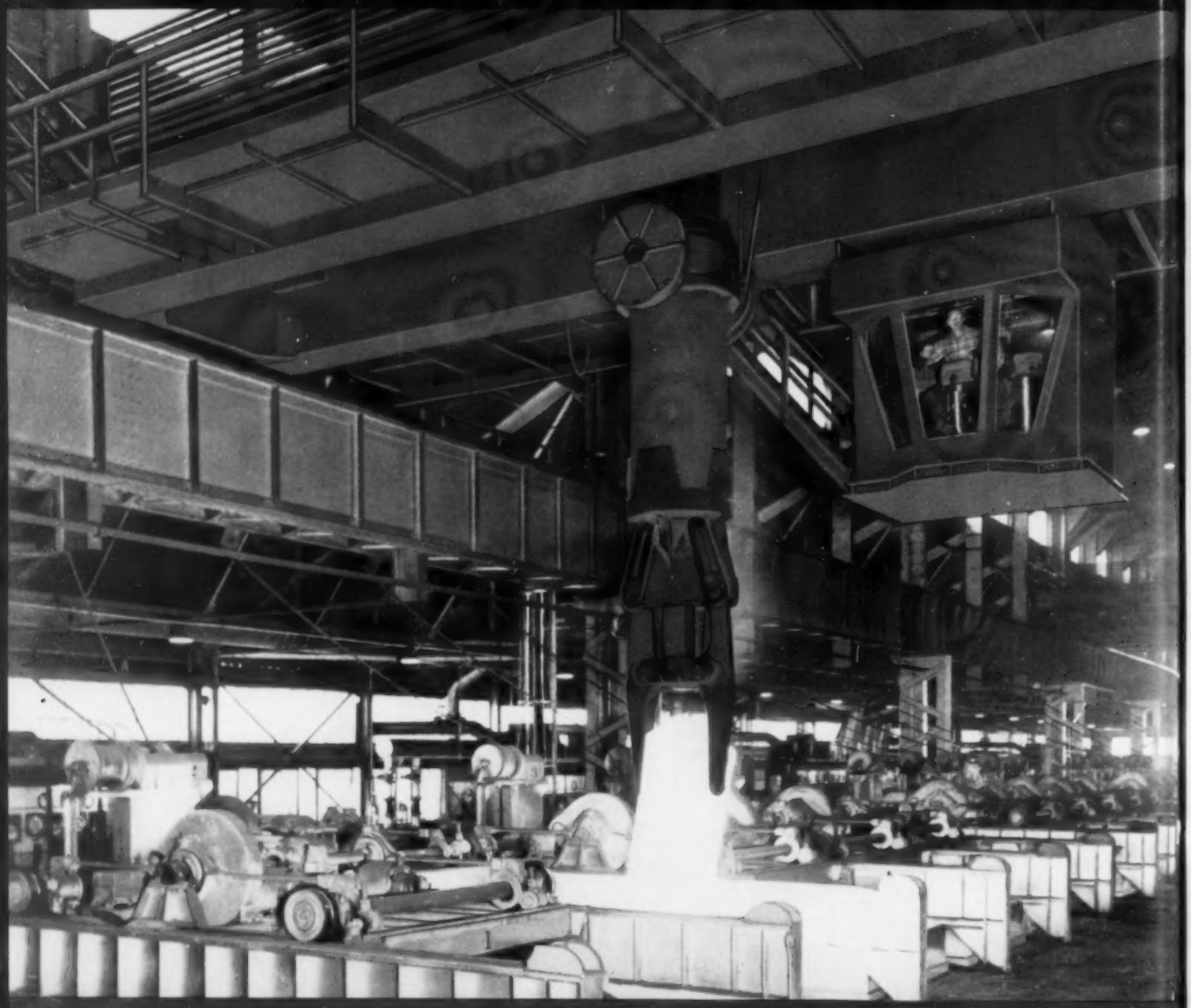


SELAS *Heat and Fluid Processing Engineers*

CORPORATION OF AMERICA
DRESHER, PENNSYLVANIA

DEVELOPMENT • DESIGN • CONSTRUCTION

something new in SOAKING PIT CRANES



• This 20-ton telescopic ram soaking pit crane is designed to afford the operator maximum visibility. The operator is located in an air-conditioned cab attached to the bottom of the crane girder at approximately the center of the span. We also design this type of crane with the operator located on the deck of the trolley where he is best protected from the heat.

The tongs are designed to revolve 360 degrees and with a range to suit your ingot sizes.

The torque required to revolve the tongs is transmitted through the hollow square telescopic tubes. These flexibly connected tubes are designed with sufficient strength to safely tip the trolley.

Alliance engineers specialize in designing BIG material-handling equipment. Consult them. They'll help you work out practical, efficient solutions to your handling problems.

"Give us the Runway and we'll lift the World"

THE Alliance MACHINE COMPANY

FOUNDED 1901 MAIN OFFICE ALLIANCE, OHIO

LADLE CRANES • GANTRY CRANES • FORGING MANIPULATORS • SOAKING PIT CRANES • STRIPPER CRANES • SLAB AND BILLET CHARGING MACHINES • OPEN HEARTH CHARGING MACHINES • SPECIAL MILL MACHINERY • STRUCTURAL FABRICATION • COKE PUSHERS

Equipment News...

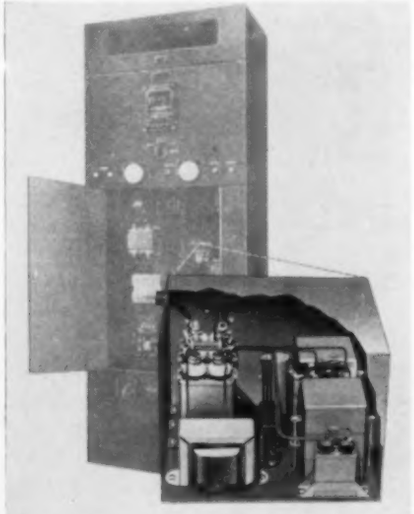
PRECIPITATOR CONTROL

▲ Western Precipitation Corp., has recently introduced the "Transistomatic" precipitator control. This unit sets entirely new standards in the automation of Cottrell precipitator units.

The Cottrell precipitator recovers dust by passing it through an electrostatic field. The dust particles become electrically charged and are attracted to metal plates placed in the gas stream and thus are "precipitated" out of the gas. The process is capable of very high recovery efficiencies and of removing even the extremely small dust particles.

However, it is characteristic of the process that the electrical voltage which can be impressed upon the gas stream varies from minute to minute, depending upon the nature of the gas, the moisture content, the amount of dust loading the gas is carrying, and numerous other factors.

Since the efficiency of the process is dependent upon placing the maximum-possible voltage on the gas stream short of "flashover," it is

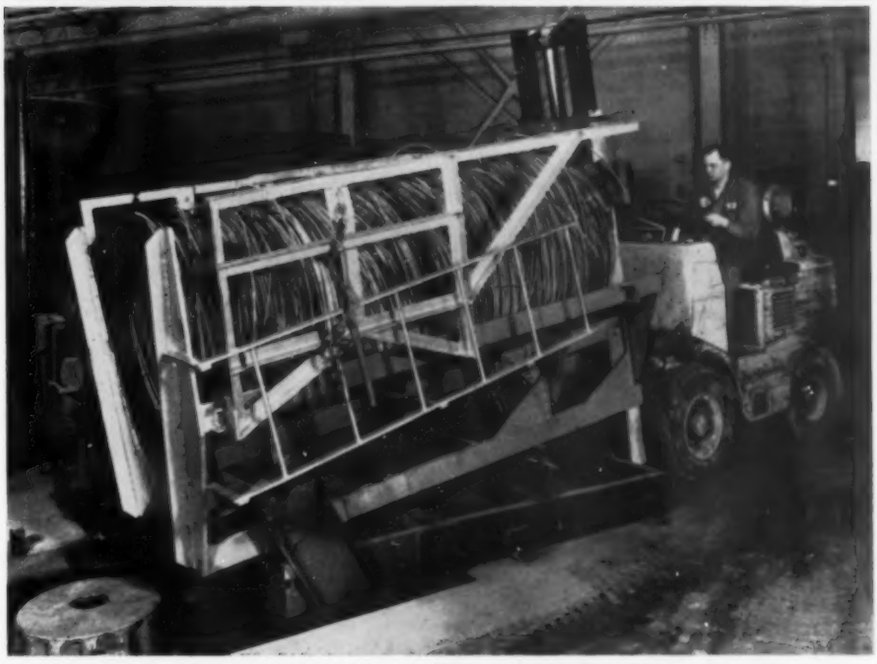


essential that this voltage be continuously adjusted to the fluctuating characteristics of the gas stream. This can be done manually, but high labor costs and frequently inaccurate control make some form of automatic control essential for optimum operating efficiency and lowest overall costs.

Various types of automatic controls have been developed using vacuum tubes, relays, electronic counters and other complicated high-maintenance parts. But not until the development of the new "Transistomatic" control has a unit been available that requires no maintenance, no parts replacement and uses only what electronic engineers term "all-static" components. The "Transistomatic" unit is completely sealed in electronic potting compound so that it is unaffected by moisture, dust, humidity or other environmental factors.

The "Transistomatic" unit also embodies an advanced type of "sensing" principle that integrates total surge current in relation to time. This provides a dynamic, continuous system of evaluating rate of surge current—not the intermittent "step process" heretofore used in which sparks are counted over a fixed period of time. This principle assures an entirely new standard of continuous pin-point accuracy in controlling precipitator voltage.

NEW MACHINE FACILITATES COIL HANDLING



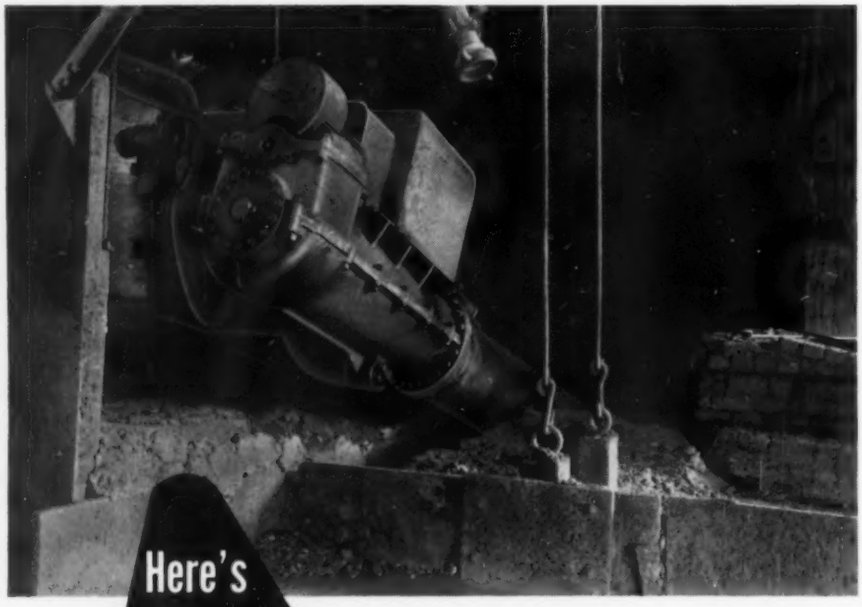
A hydraulic loading and stripping machine that simplifies handling of rod and wire coils was recently developed by The Lee Wilson Engineering Co., Inc. The new machine is designed to load or unload a complete stack of coils in a single operation with only one operator in attendance. By using the standard ram truck of "C" hook, the stack of coils to be loaded is placed in the trough of the loading machine. The machine upends the coils to a nearly vertical position over the coil pit which holds the empty spider. Hydraulic cylinders position the spider and elevate it up through the stack of coils in perfect position for crane handling. Unloading is simply the reverse operation.

REFRACTORY

▲ The Refractories Division, H. K. Porter Co., Inc., has announced a new refractory, "Permanent Hot Top Castable," which will increase hot top life and reduce hot top costs per ton of steel produced.

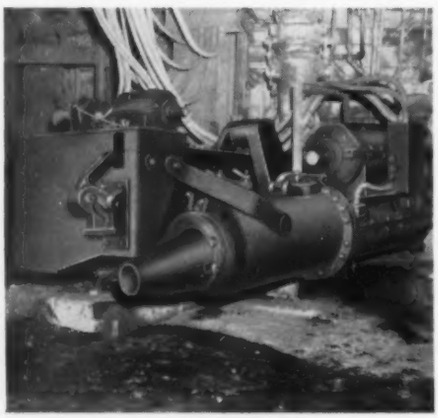
Manufactured at Porter's Laclede-Christy Works in St. Louis, the castable is a refractory lining used as a monolithic lining in permanent floating head hot tops. Service life of the average size hot top casting lined with PHT Castable is 125 heats as compared with 30 to 40 heats when preburned refractory shapes are used as a lining. Accompanying benefits are reduced main-

180 Bailey CLAY GUNS
IN CONTINUOUS SERVICE



Here's Why...

- Exceptional Power
- Accurately Controlled
- Operated by Three Separate Motors



With clay pressures of 600 psi, these guns provide ample power for plugging and maintaining long tapping holes. A unique mounting and operating system assures fast and accurate positioning with the ultimate in safety.

Bailey Electric Plunger Clay Guns are adaptable to both blast furnaces and large electric furnaces.

Write for Bulletin

WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA

tenance, less labor and less inventory.

A permanent steel form is bolted to the floor. If insulation is used, a vapor barrier over the insulation is recommended. The form is coated with grease. The casting is placed around the form, and space between form and casting is filled with PHT Castable. Vent holes are made in the castable with a steel rod, ⅛ in. in diam, spaced on 6-in. or 8-in. centers. These holes aid in the deletion of moisture. Rods are removed before permanent set takes place. Following permanent set (8 to 10 hr after pouring) the lined hot top is removed from the form and subjected to low heat (gas flame) until moisture is dissipated.

PALLET TRUCKS

▲ Now in production at Automatic Transportation Co. is a new design of its 4000 and 6000-lb low lift pallet industrial trucks — Transporter Models WPY-4 and 6—which will provide users with space for approximately 50 per cent additional power as compared with conventional types, according to the company.

Increasing the power source was realized by enlarging the battery compartment to 15½ in., enabling

it to accommodate up to 6 cell 23 plate lead acid batteries, or the equivalent. The new models are exceptional in that a majority of manufacturers' sizes and types of batteries now on the market for use in driver led equipment can be used.

Ability to use larger batteries is particularly important when equipment is operated under heavy current draw conditions such as steep ramps and where work is continuous with full capacity loads.

Even with the larger battery compartment, this low lift unit measures only 29 in. plus length of load. It has

a maximum steering angle of 200 deg affording excellent maneuverability in narrow aisles.

Simplicity in maintenance is also a salient feature of the new trucks. Removal of two hand screws holding the steel cover in position exposes the power unit. Maintaining the gear case oil level is the only lubrication required in the power head and adjustments to brake and electrical components can be made in a matter of minutes. Greasing at only three points permits lubrication of all other load bearing surfaces.

SEALS

▲ New Chempac Teflon Clipper Seals, which will enable industrial plants to obtain positive sealing in the presence of and in contact with active solvents and corrosives, are now being placed on the market by Johns-Manville Corp.

These new seals have successfully contained oils with varying aniline points that are destructive to many compounds. They have also proved effective against such widely diverse fluids as rocket engine fuel, perchlorethylene, destructive insecticides and various refrigerants.

The body of the seal is made entirely of Teflon and is encased in stainless steel or other corrosion resistant alloy. The seal lip is actuated by a spring also made of stainless alloy. The unit is assembled so that all components are in absolute concentricity. This precise assembly allows maximum sealability with minimum lip wear.

The seal incorporates the correct amount of flexibility for maximum sealing effect. When installed, an effective seal is formed initially by the interference fit of the lip. In service, wear progresses to a point of equilibrium where it practically ceases and the seal continues to serve effectively.

Recommended shaft finishes for use with these seals range from 4 to 8 microinches (Superfinish). Shaft diameters: Springless as small as one-eighth of an inch; Spring Loaded ½ in. up.

POWER CONNECTORS

▲ The Delta-Star Electric Division of the H. K. Porter Co., recently introduced a complete line of aluminum power connectors for tubing

Case histories prove

TM Triple-Safe ALLOY CHAIN

increases safety,

cuts chain costs!

GAMMA RAY QUALITY CONTROL!

X-Ray type testing of master, joiner and end links assures safe, trouble-free welds.

CONTROLLED ATMOSPHERE HEAT-TREATING

on all popular sizes provides uniformity throughout the sling assembly.

EXCLUSIVE TM PATENTED TAYCO HOOKS!

I-Beam type design plus alloy steel construction mean extra safety!

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You get a certificate of test with every TM Alloy Chain. It bears the chain's guarantee . . . proof test . . . serial number.

Chain is our specialty, not our sideline!

TAYLOR MADE A GREAT NAME IN Chain SINCE 1873

Contact your nearest Distributor or write
S. G. TAYLOR CHAIN CO., INC.
Box 509, Hammond, Indiana
Eastern Plant—Pittsburgh, Pa.

Exclusive with the Heroult:

100% Mechanical Operation

The Heroult is the *only* 100% mechanically operated electric furnace on the market! All of the movements are handled by motor-driven gear mechanism.

This is a very important advantage—as any engineer will readily tell you, for it eliminates so many maintenance difficulties.

There is nothing about the operation and servicing of the motor-driven, heavy-gear mechanism of the rugged Heroult that any good maintenance man can't easily take care of himself. Seldom, if ever, will you find it necessary to call in an outside maintenance man to keep your Heroult performing efficiently.

Modern Heroult electric furnaces are available in sizes ranging in holding capacity from 6,000 lbs. up to and in excess of 400,000 lbs. Both gantry and swing-type roof-moving mechanisms are available. Door-charging furnaces and furnaces of special design, including units equipped with austenitic steel bottoms to permit induction stirring, can also be supplied.

We welcome an opportunity to help you select and install the Heroult best suited to your requirements. An inquiry to the nearest office will bring complete details.

Heroult

ELECTRIC MELTING FURNACES

USS TRADE MARK

AMERICAN BRIDGE DIVISION

UNITED STATES STEEL CORPORATION, GENERAL OFFICES: 525 WILLIAM PENN PLACE, PITTSBURGH, PA.

Contracting Offices in New York, Philadelphia, Chicago, San Francisco, and other principal cities.
United States Steel Export Company, New York

SEE THE UNITED STATES STEEL HOUR. It's a full-hour TV program presented every other week by United States Steel. Consult your local newspaper for time and station.

UNITED STATES STEEL

to tubing, cable to cable, tubing to cable or terminal lug connections, etc.

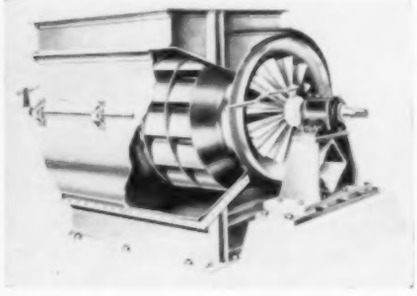
This line of connectors is designed for easy installation, high electrical conductivity, and positive mechanical connection thus insuring continuous efficient service over a long period of time.

Some of the features stated for these new connectors are: strong positive gripping action; positive wrapping action assures a low resistance joint not subject to loosening due to vibration or strain; designed to carry full rated current of the conductors with temperature rise of connector not exceeding that of conductor; edges and ends of connectors are rounded to eliminate abrasion; recessed bolt heads for single-wrench assembly and disassembly; meet NEMA standards in every respect.

FORCED DRAFT BLOWER

▲ A new airfoil mechanical draft fan for central power stations and heavy industrial service has been announced by the Chicago Blower Corp. Engineered around an airfoil backward curved non-overloading type centrifugal wheel, the fans give mechanical efficiencies up to 92 per cent.

The fan's hollow section airfoil blades are designed on the same



principle as an airplane wing. Smooth passage of air over the blade surface eliminates eddy currents, lowering the noise level 20 to 40 per cent and requiring less horsepower.

The fan furnishes static pressure from ¼ in. to 32 in. in volumes ranging up to 1,097,940 cfm and temperatures up to 900 degrees F.

Inlet vane controls provide for manual or automatic regulation of fan output. The vane control is constructed as an integral part of the inlet cone. Since it depends on a cam action design, there is no blade flutter.

Housings are constructed of continuous-weld heavy plate steel. Flanged inlets and outlets and quick-clamp access doors are supplied on all housings.

DRIVE SYSTEM

▲ An electrical drive system has been designed by General Electric Co. for a Youngstown Sheet & Tube Co. blooming mill.

The system will enable the mill to be reversed from 50 rpm to 50 rpm in only one second. Development of the system at Schenectady, N. Y., was accomplished through the use of electronic computer studies.

The electrical system's major components include a 12,000 hp twin drive motor, a 10,000 kw motor-generator set, and control, ventilating and power distribution equipment. The inverted arrangement of the twin drive units, forged couplings, and integral ventilation are unique features of the drive motor. The inverted motor arrangement places the front motor above the spindle shaft extension to the back motor, making each motor equally accessible.

A specially designed static switching system will direct operation of the mill's main drive and master control circuit. General Electric

for intense concentration of heat...

The BLOOM HTR BURNER

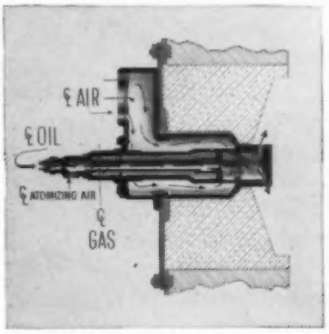
The Bloom HTR Burner provides identical operation on either gas or oil.

This burner enables the engineer to design a heat pattern with excellent results, because it has the unique characteristic of providing localized high heat release with low forward velocity. The burner can be located to fire directly at the material without flame impingement. Roof firing is easily accomplished and provides uniform hearth temperature.

This burner has been very successful in its application to tube upset furnaces; continuous strip annealing, coating, and pre-heating lines; high speed billet heating furnaces; and batch-type forge furnaces.

The Bloom High Thermal Release Burner with its sturdy construction is ideal for applications requiring speed and precision heating.

PATENT PENDING



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HERC-ALLOY® HAMMERLOK®

made the initial application of static switching in the steel industry last year with the installation of a system which replaced the master motor-operated rheostat and associated master control on a four-stand tandem cold mill at Youngstown's Indiana Harbor plant.

Power distribution equipment includes an outdoor substation, metal-clad switchgear, and a unit substation.

BAR-TUBE PRINTER

▲ The Pannier Corp. has announced a smaller offset wire bar and tube printer especially designed to handle material from ⅛-in. to 4-in. o.d. without changing guide wheels. The power unit has a magnetic starter that activates motor as material passes through open limit switch. This eliminates any

excessive build-up of ink on the offset printing wheel and assures clean, clear marking. The small offset printer is available as either left or right hand feed so that it fits into conveyor line system without disrupting present line movements.

This unit will print a continuous message set on 24-in. offset printing wheel in type sizes from 1/16 in. to 1 in. A ½-hp, 3-phase, variable speed motor chain drives, with a floating idler sprocket, only the marking head to forward material through unit with an extremely light printing pressure. Speed can be safely controlled from a minimum of 45 lin ft to a maximum of 450 lin fpm. Material being marked is supported by three fibre rolls that are not pow-

3 ideas

for turning your outdated machine tools into money-makers

If you have boring mills, planers, lathes, grinders—machine tools of any type or size—which have lost their accuracy through hard use, Simmons *Engineered Rebuilding* guarantees to return them to the manufacturers' original specifications *at half or less than half the cost of a new machine!*

Simmons *modernizes* inefficient equipment inside out, boosts feeds and speeds through increased horsepower, new gearing and power transmission methods, automatic controls, and other up-to-the-minute features. Result: Efficient high-speed equipment for today's production. Savings, in cost, delivery time, and performance, are substantial.

Standard machine tools can be adapted to your exact needs through *conversion,* at a fraction of the price of new or special equipment. Simmons has turned old planers into accurate planer-grinders; standard lathes into special-application machines for multiple-machining jobs; outdated planers into automatic jet plane "skin" millers. *Savings to Simmons' customers: tens of thousands of dollars.*

FIND OUT TODAY *about the big savings available in rebuilding, modernization and conversion at Simmons. Write, wire or telephone: Simmons Machine Tool Corp., 1712 N. Broadway, Albany 1, N. Y.* (In NYC: 50 E. 42 St., New York 17.)

SIMMONS
MACHINE TOOL CORPORATION

SINCE 1910...Builders and rebuilders of unconditionally guaranteed machine tools

ered. The standard support rolls are designed primarily for round material but will handle a great variety of shapes; some extruded shapes may require special support rolls to assure clean, smudge-free impressions.

This same unit is also available as a friction operated unit for use with continuous flow materials. Pannier's larger model offset bar wire and tube printer is recommended for printing materials greater than 4 in. o.d.

HOT SINTER SCREEN

▲ Development of a screen capable of handling 132 tons per hr of hot sinter at an approximate temperature of 1400 F with hot spots to 2400 F has been announced by Allis-Chalmers Manufacturing Co.

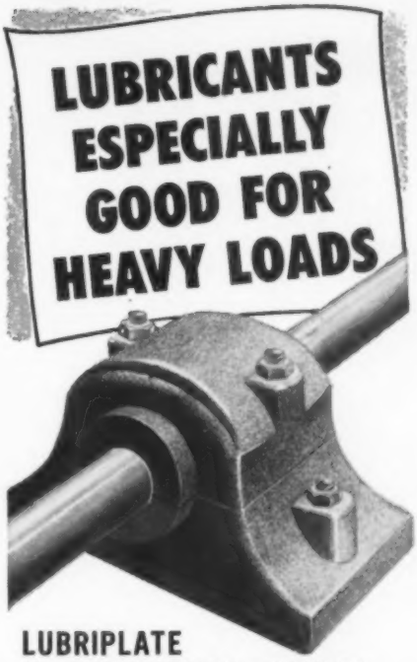
The screen's heat and wear resistant grate sections of high chrome iron are bolted to seven pallet assemblies with stainless steel bolts. Each self-supporting pallet assembly is made of tubular type 316 stainless steel cross members welded to stainless steel longitudinal angles for bolting to the screen body.

Tubular cross members are open on each end for air circulation. Clearance is provided between sections to allow for longitudinal expansion. High temperature springs are located on the outside of the body. These permit a pre-determined tensile load on the bolts sufficient to hold the pallet sections to the screen body, thereby allowing transverse expansion of the pallets.

The pallets are keyed mid-point to the screen body to permit longitudinal expansion in either direction. Side plates and back plate of the screen body are of T-1 steel. The back plate has 316 stainless steel plates to deflect radiant heat from the fines hopper and to provide for air circulation between the back plate and deflector plates.

The screen is equipped with a twin mechanism center drive located at the extreme feed end away from the hot zone area.

Operating at a speed of 800 rpm with a $\frac{3}{8}$-in. amplitude, the screen will be used in a sintering operation which agglomerates the fine ore into larger size particles to provide satisfactory sized feed for blast furnaces. Large lumps resulting from sintering are generally crushed to a 6-in. nominal size. The fines resulting



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Nos. 130-AA, 630-AA and 930-AA
are grease type lubricants especially formulated for use in bearings and on other machine parts subject to heavy loads. Have extremely high film strength, marked adhesiveness and water repellence.

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are most satisfactory fluid type lubricants over a wide range of temperatures. Due to their high film strength, they are ideal for use where heavy loads are encountered.

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from the hot crushing operation are immediately screened on a hot sinter screen to make available minus 3/8-in. fines to admix with the raw ore fines as feed to the sintering machine.

Many operators are of the opinion that the mixing of hot sinter fines with raw ore fines improves the efficiency and increases the capacity of the sintering machine and also reduces the fuel required for the sintering operation.

In the past, the maximum temperature that could be screened on a vibrating screen was 600 F.

CRANE CONTROL PANELS

▲ A new line of d-c crane control panels featuring front-connected devices, unit base construction, and improved operational features is now available from the General Electric Co.

Available in NEMA classifications I, III, IV, and V, the control has broad applications in steel and other heavy industries where hoists, bridges, and trolleys are used.

Exclusive use of newly designed front-connected contactors and relays makes possible complete maintenance and servicing of the panel from the front. Removable front doors using pin-and-socket type hinges also contribute to simplified maintenance. In addition to space saved by elimination of the rear door, engineers have reduced panel dimensions to provide an over-all reduction of 50 per cent in bridge floor space requirements.

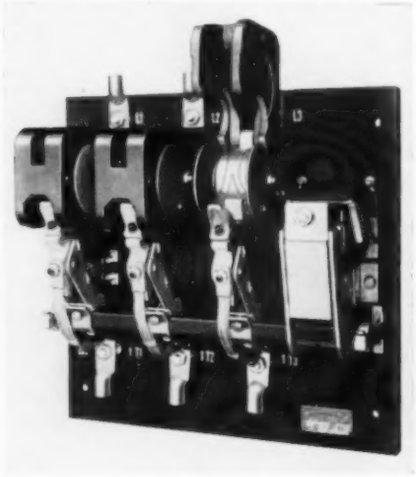
Company engineers say the panel offers the best speed-torque characteristics available. Correct kick-off torque is assured for all loads. The control provides slow light-load speeds, slow landing speed, accurate spotting of loads, and stable lowering speeds for heavy overloads. No downward drift occurs with 100 per cent hook load. Overload and undervoltage protection is built into the panel.

The new d-c line includes: cab-operated hoist control with reversing, dynamic-braking lowering; cab-operated bridge and trolley control with reversing plugging; cab-operated crane protective panel for all motions; and floor-operated composite hoist, trolley, and bridge control.

For reversing dynamic-braking lowering hoists and reversing plugging bridges and trolleys, the control is available for either single or duplex motor applications, with or without protection.

HEAVY-DUTY CONTACTOR

▲ The Euclid Electric & Mfg. Co. announces a new Bulletin 5005, Size 5, 300-ampere, a-c magnetic contactor. While this mill-type contactor was specifically designed for



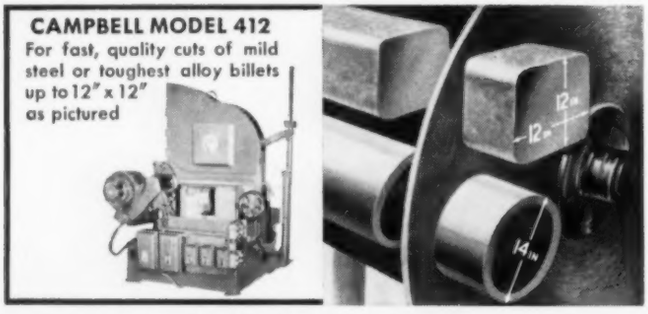
starter, machine-tool and heavy-duty mill and crane applications, it is finding use in all types of service where severe operating conditions place a premium on lasting performance.

The exclusive arc-centering feature assures more efficient arc interruption and longer arc-shield life. Another exclusive feature is the single armature adjustment. This feature plus the floating, self-aligning armature provides quiet operation.

Campbell
Abrasive Cutting Machines

Abrasive Cutting Know-How

Know-How is just as vital to top performance in abrasive cutting as in any other machine tool operation



Users of Campbell Abrasive Cutting Machines get Tremendous Savings with Fast, Accurate, Quality Cuts of Mild Steel or Toughest Alloys

Write us and we will gladly send you helpful information on the working capacities of the 16 models of CAMPBELL Machines and the CAMPBELL Operating Features that explain the outstanding performance of these machines in cutting a wide variety of shapes and sizes of stock—channels... bars and tubing from the smallest to 14" diameter ...plate up to 4" thick and 20 feet long ...billets up to 12" x 12".

CAMPBELL Machine performance is well illustrated by the **Model 412** pictured above. This machine cuts through 12" x 12" billets of mild steel or toughest alloys (even titanium) in the almost unbelievable time of 6 to 10 seconds per square inch...*with quality cuts.*

Here are some of the operating features that account for comparable speed and quality of cuts by CAMPBELL's 10 high speed production models...two of them fully automatic for highest production.

Oscillation of the Cutting Wheel to maintain cutting speeds and greatly lengthen wheel life is prescribed by CAMPBELL for all solids cuts over 2" in diameter.

Wet Cutting gives maximum assurance of Quality Cuts.

Ample Power, essential to good performance, is supplied for the Model 412 by a 40 HP motor.

Sound Work Holders — essential to accuracy.

For greatest abrasive cutting accuracy, CAMPBELL provides two oscillating machines that rotate the work—round bars or tubing from 3" to 14" diameter.

For further information write for the illustrated Bulletin DH-460-B

ACCO

Campbell Machine Division • AMERICAN CHAIN & CABLE

928 Connecticut Avenue, Bridgeport 2, Connecticut

The frame and all structural members are stamped steel with welded joints to guarantee permanent rigidity. Bearings are lifetime, self-lubricating, porous bronze. Shunts are extra flexible stranded copper. The over-size stationary and moving hard-drawn copper contacts are identical and interchangeable. Contact springs are stainless steel.

OXYGEN STORAGE TUBES

▲ Vertical pressurized oxygen storage tubes, newcomers in the steel industry, have been installed by Air Products, Inc., for Granite City Steel Co., at Granite City, Ill.

Towering 80 ft above the ground, the 30 tubes hold 125,000 standard cu ft of 99.5 per cent purity oxygen, providing Granite City with reserve oxygen for peak periods.

Stored under 450 lb psi pressure, the high-purity oxygen is generated at the steel company's new 60,000,000 cu ft per month oxygen generator, leased from Air Products.

The vertical tubes are "firsts" for the steel industry. Up to this time storage tubes have been installed horizontally. The new installation at Granite City requires only a fraction of the space necessary for a flat bank.

FORGING PRESS

▲ A new 2000-ton hydraulic forging press for hot working of steel, titanium and other metals has been placed in operation at the Dunkirk Works of Allegheny Ludlum Steel Corp.

The new press substantially increases the forging capacity of the Dunkirk Works, which is a producer of tool and die steels, stainless steel wire and other steel products. The new press also substantially increases the maximum size of forgings made by Allegheny Ludlum. It can forge steel shapes up to 80 in. in width and weighing as much as 28,000 lb in a wide variety of shapes, including large size blocks, disks, sleeves, rings, round bars, flats and billets.

Of an unusual design and believed to be the first of its type built in this country, the press and its auxiliary equipment are housed in a new, stainless steel-clad building containing about 50,000 sq ft of floor space. The new press incor-

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Markal Paintstik MARKERS!

PERMANENT—FADEPROOF—WEATHERPROOF

Marks remain visible under any extremes of heat up to 2100°F. or cold down to −50°F. and under any weather conditions. For marking raw materials or finished products. Markal Paintstik Marks stay on until *you* want them off.

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. . . complete lamp protection with *Adalet* vapor-tight lighting

Inside or outside, wherever the lighting need, get better protection, greater safety with Adalet vapor-tight and weather-proof lighting.

From junction box to reflector, globe and shock-proof guard (that can't shake off), Adalet has a complete line . . . quality built for rugged service, engineer-designed for better lighting. 100, 200 and 500-watt sizes. Get the whole story — send for Catalog Section E.

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for all types of
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Hyde Park Rams are available in Chilled or Alloy Iron.

Furnished in hardness range to meet your specification . . . ground to your required size.

On your next replacement of Rams — or for new equipment—consult us. Our engineers will be glad to assist you.

Red Circle Rolls for every Purpose

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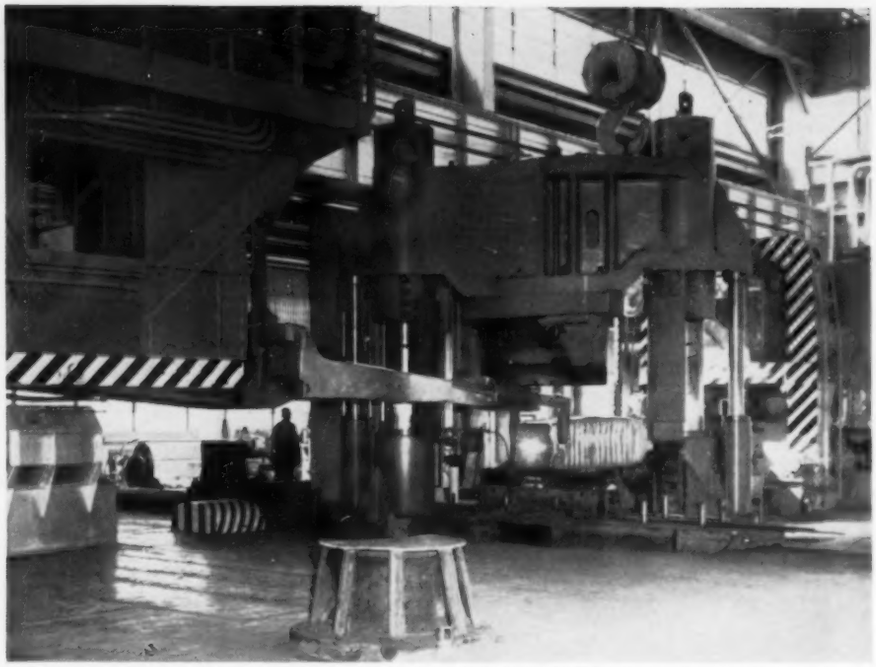

Charging crane (at left in picture) prepares to withdraw a forged ingot from the 2000-ton hydraulic forging press at Allegheny Ludlum-Dunkirk Works. Substantially larger size products, smoother finish, denser and more uniform metallic structure, are among the qualities produced in forgings by the big press in comparison with smaller-capacity hammer forging equipment.

porates automatic control features and auxiliary equipment designed for fast, economical hot forming of metal shapes.

A substantial portion of the time on the new press will be devoted to forging extra large sizes of tool and die steels. It is one of the largest presses in the industry to be used in forging these products.

The new forging press was built by Lake Erie Engineering Corp., to specifications worked out in cooperation with the engineering department of Allegheny Ludlum.

Book Reviews

"The Handbook of Powered Industrial Trucks," a 96-page publication is the result of nearly three years' effort. It is the most complete and authoritative handbook ever developed on the subject of industrial trucks, by the Industrial Truck Association, Washington, D. C. It is divided into five convenient sections: industrial truck applications; cost savings through industrial truck handling; planning for and selection of industrial trucks; industrial truck engineering data; and industrial trucks and the future.

The publication has been designed to answer the needs of purchasing, operating, production, maintenance and material handling personnel in all industries. It contains dozens of case studies showing specific industrial truck applications, as well as nearly two hundred illustrations of various truck types, attachments, containers and load carrying devices. In addition, numerous engineering tables, graphs and charts are used to present practical truck operating data.

Copies of the handbook may be obtained from the Industrial Truck Association, Ninth and F Streets, Washington 4, D. C. Cost per copy is $5.00, 96 pp., $8^1/_2 \times 11$ in., paper covers.

"New Lessons in Arc Welding," is out in a new second edition of this well-known text. It is completely rewritten and revised to include new procedures, information on latest machines and electrodes, modern teaching methods for manual arc welding. 320 pp., well illustrated with pictures and drawings; 6 x 9 in. size; gold embossed, simulated leather cover; price $1.00 postpaid in U. S. A., $1.50 elsewhere. Publisher is The Lincoln Electric Co., Cleveland, Ohio.

"Atomic Energy Facts," issued by the U. S. Atomic Energy Commission provides industry with up-to-date compilations of information

(*Please turn to page 258*)

THE ENGINEERING MART

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Book Reviews

(*Continued from page 256*)

in the atomic energy field. The 216-page volume, illustrated with 86 drawings, photographs, and flow charts, is a handbook on nuclear operations in the United States for industrial management and others active or interested in atomic energy. It combines and organizes material from many Commission sources.

Atomic Energy Facts is entirely devoted to peaceful uses of atomic energy. It describes the organization and functions of the Commission, technical information services the Commission provides and how to use them, conditions under which qualified individuals and organizations may gain access to classified information, special materials and services available from the commission, and how to obtain patents and licenses.

Other topics discussed include the Commission's programs for training and education in nuclear science and technology, co-operation with friendly nations in peaceful applications of atomic energy, activities of major AEC contractors, raw and feed materials, reactor development, and radioisotope development.

The volume contains eight appendices covering: basic principles of controlled thermonuclear program, categories of restricted data available to access permit holders, depository libraries of U. S. Atomic Energy Commission, a bibliography, power reactor data tables, data for representative research reactors, gamma irradiation facilities, and a catalog of materials standards.

The book, paper bound, may be purchased for $2.00 from the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C.

"Elements of Heat Transfer," Third Edition by Max Jakob and George A. Hawkins has recently been published by John Wiley & Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. The book contains 317 pages, 6 x 9 in., is cloth bound, and sells for $6.75. The third edition of this work maintains the presentation of basic principles and applications to simple problems, it describes the fundamental modes of heat transfer, and includes a combination of two or more modes. New subjects are supplemented by easy-to-follow examples. Newer materials have been added to conform with modern usage. The final chapter on mass transfer is entirely new and discusses the similarity between heat and mass transfer. Other new features are: new table on thermal conductivity of liquid metals; added section on the use of equivalent circuits for the solution of problems; information on one type of thermal analyzer; additional material on the analysis of engineering systems; and sections that cover the heating of liquid metals in turbulent flow-through piles, the hydrodynamic and thermal boundary layers, convective heat transfer at higher velocities, and the analogy between electrical and thermal circuits for convective heat transfer. Also included are a section of heat exchanger effectiveness to supplement earlier material on heat exchangers, and information on the differences between nucleate, partial film, and film boiling. A section on gas radiation has been added.

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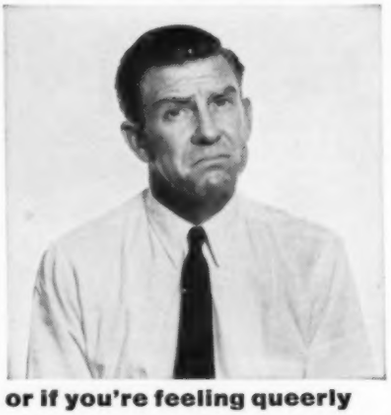
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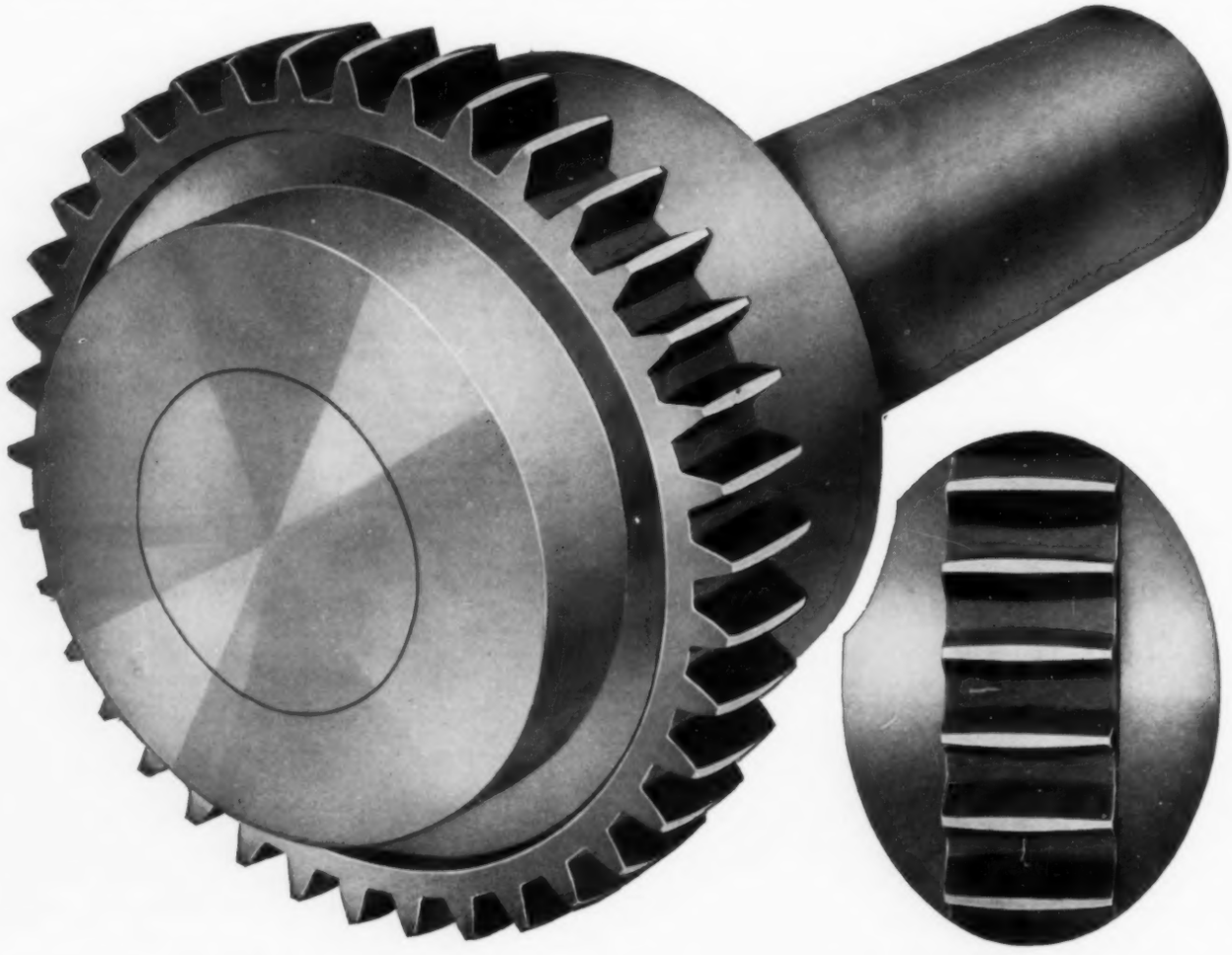

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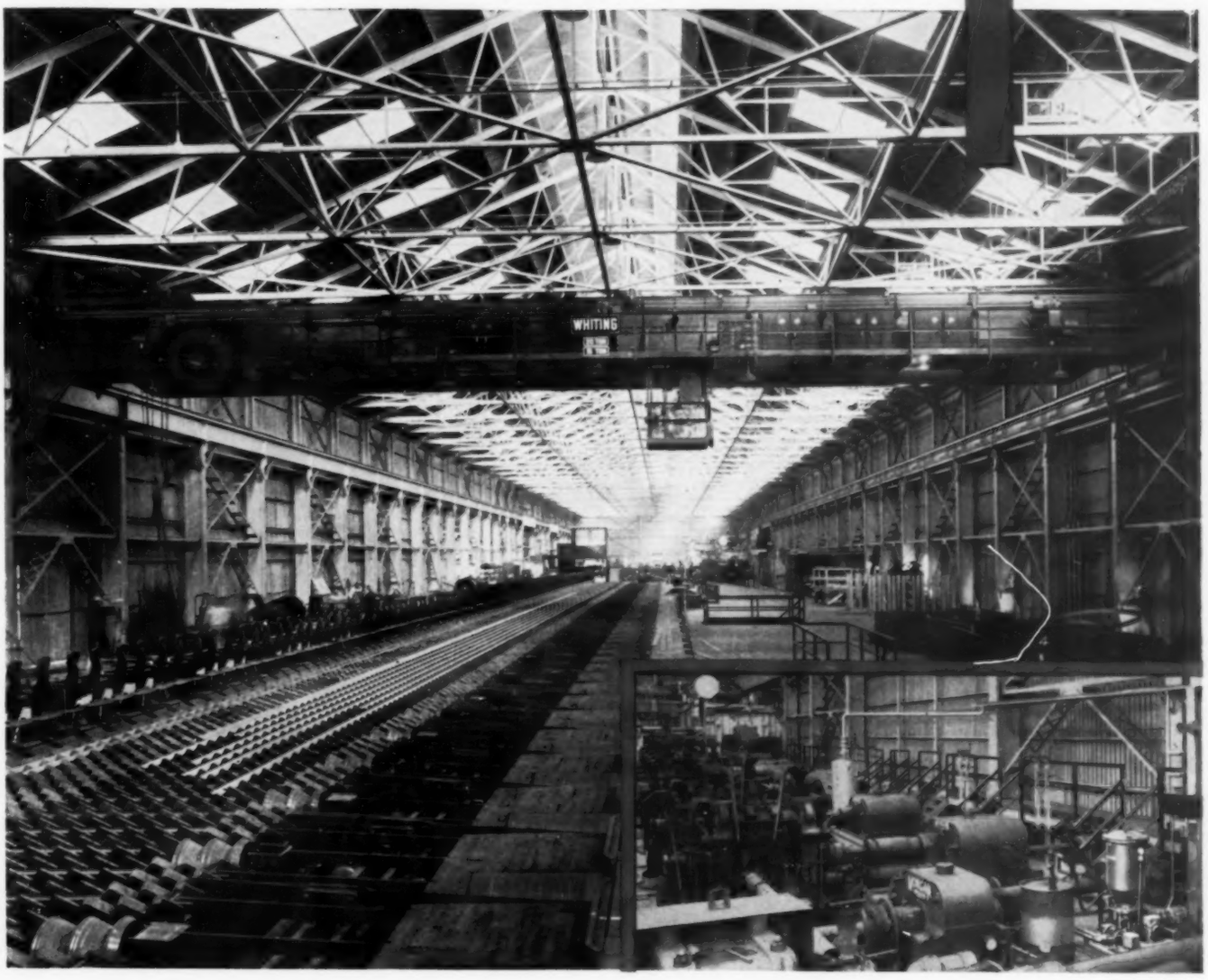

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